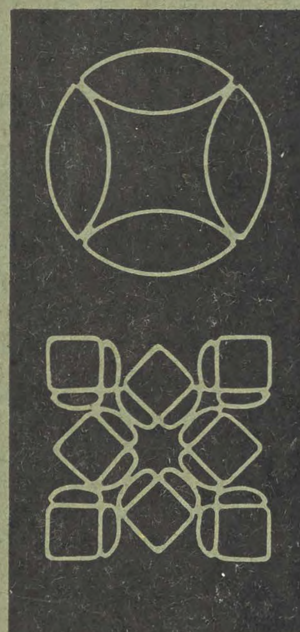
UNIT JEWELLERY
A HANDBOOK IN SIX PARTS
BY R. LL. B. RATHBONE

VERY FULLY
ILLUSTRATED
THROUGHOUT



EACH PART
MAY BE HAD
SEPARATELY

CRAFTSMANSHIP
WITHOUT DESIGN
IS LIKE A VESSEL
HAVING NO PILOT

PART
II

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UNIT JEWELLERY

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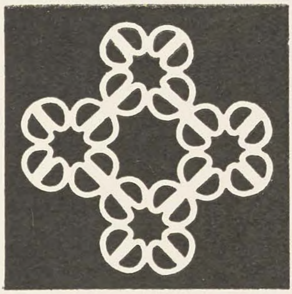

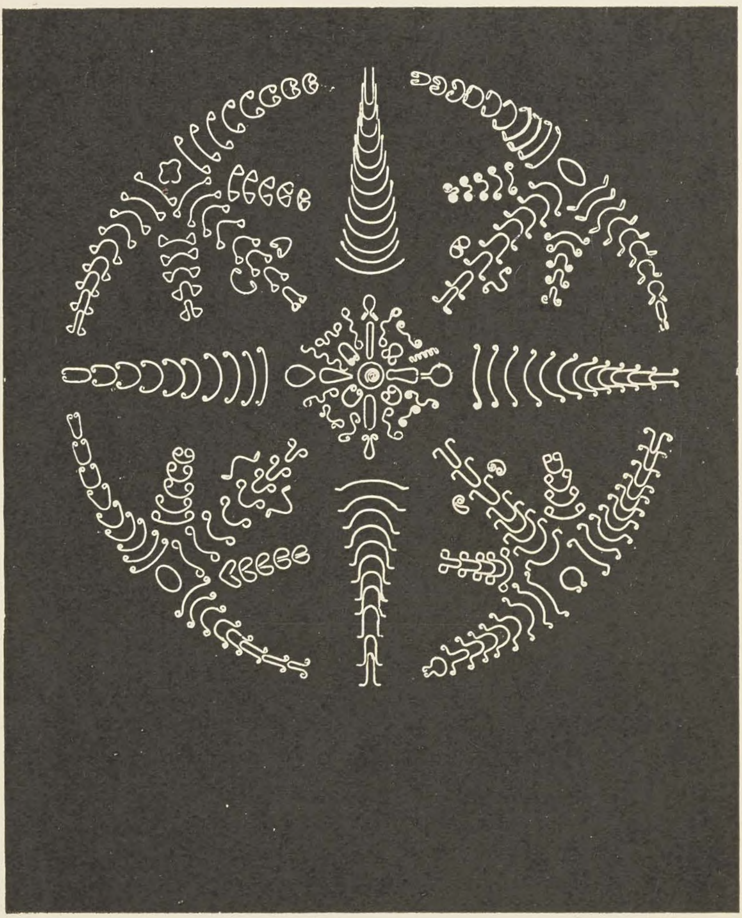

FIG. 14.—Units of the crescent type.

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UNIT JEWELLERY

A HANDBOOK FOR CRAFTSMEN IN SIX PARTS (SOLD SEPARATELY) ILLUSTRATED WITH MANY DRAWINGS BY THE AUTHOR AND WITH A PROFUSION OF PHOTOGRAPHIC SILHOUETTES OF ORNAMENTS AND DETAILS MADE BY HIM FOR THAT PURPOSE AS ALSO WITH PHOTOGRAPHS OF TOOLS AND OF SOME EXAMPLES OF JEWELLERY SELECTED FROM NATIONAL & PRIVATE COLLECTIONS

BY R. LL. B. RATHBONE

PART II

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CONTENTS

PART II

LIST OF ILLUSTRATIONS

PART II

CHAPTER VIII

MEASURING AND REDUCING THE SIZE OF WIRE

IF we now proceed to make some experiments in building up small ornaments like those which were illustrated in Chapters II., III., and IV., for which only circular forms were used, these exercises will also provide some excellent practice in soldering. It will be necessary to have a supply of silver wire in several different sizes, and this makes it very desirable, if not absolutely necessary, to learn how to draw out wire—that is to say, to make it thinner.

The thickness of wire is generally measured by the imperial standard wire gauge (Fig. 15, A), but the whole question of gauges being a rather complicated matter, it is dealt with in Note C (p. xxxix), because it would cause too great a digression to do that in this chapter. But if the subject is new to you, that note is meant to help you to decide what kind of a gauge to buy, so that it ought certainly to be worth while reading Note C before making up your mind on that question.

For the present it is enough to add that, when referring to the one mentioned above, it is usual and convenient to use an abbreviation, such as I.S.G. or S.W.G.

Perhaps I.S.G. is the best, because the other initials are easily confused with B.W.G., which is the abbreviation for the Birmingham wire gauge, whose sizes, though very nearly the same as those of the I.S.G., differ from those of the latter just enough to cause trouble.

Assuming that you have bought a small supply of *standard* silver wire of, say, No. 18 I.S.G., cut off a length of, say, 10 feet,* and file one end of the wire so that it tapers gradually

* This would weigh just about 1 oz. (Troy).

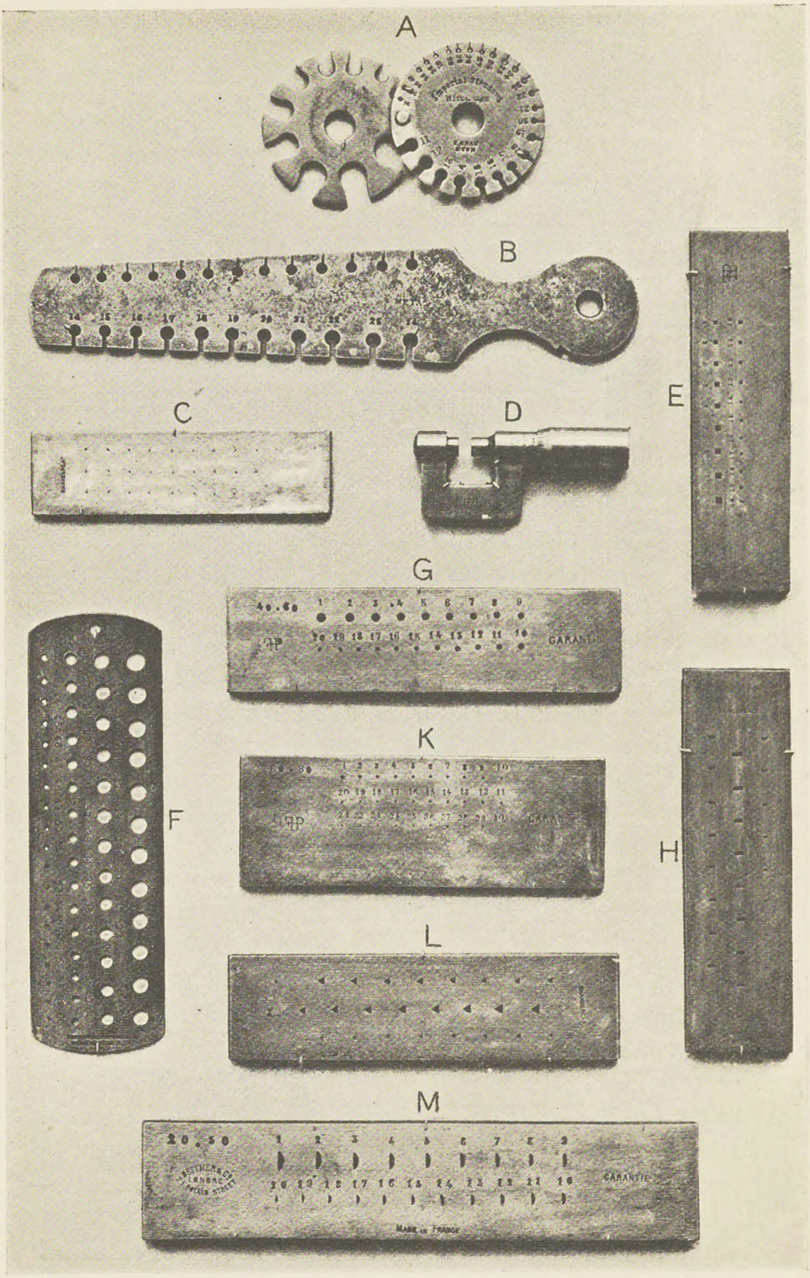


FIG. 15.—A. Imperial standard wire gauge. B. Birmingham metal gauge. C, G, K. Drawplates for round wire. D. Micrometer gauge. E. Drawplate for square wire. F. Twist-drill steel-wire gauge. H. Drawplate for flat wire. L. Drawplate for triangular wire. M. Drawplate for half-round wire.

to a fairly long point. Then take the "round" drawplate (60—90,* Fig. 15, K) and grip it in the vice (Fig. 16), so that the side on which the numbers are punched is towards you. It is not absolutely necessary to have a vice, though, for wire drawing especially, it is a very great convenience. However, the drawplates can be held securely enough in other ways, as, for instance, by means of four stout bits of wood firmly screwed down to the top of the bench, in pairs, with a space between them to receive the ends of the plate, which will then be supported while resting with its lower edge on the bench.

If you decide to get a vice, but find yourself obliged to

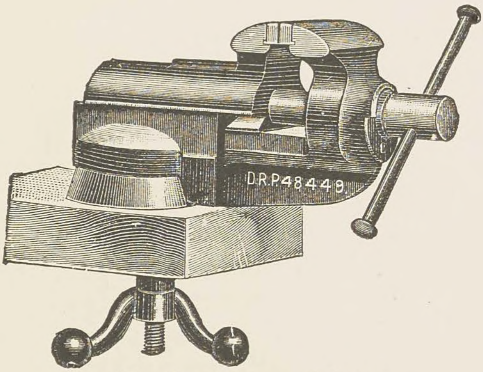


FIG. 16.—Revolving parallel vice.

observe strict economy, a cheaper one than that illustrated will do, so long as it is reasonably strong.

Now fill the holes of the drawplate with tallow from the further side, that on which the larger openings are, and push the pointed end of the wire through the hole marked No. 1 (*i.e.*, No. 61) from the far side, so that the point comes through to the side of the plate which is towards you. Take hold of the pointed end firmly with a pair of strong pliers or, if you have them, a pair of draw tongs will, of course, be better, and steadily pull the wire through. If it comes through without requiring the exertion of any force, try it in a smaller hole until you find one through which it requires some force to pull it beyond the part where it is pointed.

* The figures 60—90 indicate that there are thirty holes in that plate, the largest of which is known as hole 61, and the smallest as hole 90.

The uncertainty as to whether No. 18 wire will go through hole No. 61 in the drawplate is due to the fact that drawplates and gauges are both liable to wear with constant use, and the No. 18 wire you buy from one dealer may be a shade thinner or thicker than wire sold as of the same size by another dealer ; also, the gradations from hole to hole in the drawplate being so very slight, an almost imperceptible variation in the size of the wire may make a difference of perhaps two holes in the drawplate.

Moreover, the gauge number is only an approximate measurement, and the wire may be either an easy or a tight fit, and still be properly designated by that number. For information as to more exact methods of measurement, see Note C, pp. xxxix—xliii.

Assuming, however, that your No. 18 wire will not quite pass through hole No. 61, push the pointed end through, and then draw the wire through that hole and afterwards through the next one (62).

Before reducing its thickness any more, cut off a length of about 2 feet, being careful to leave the pointed end on the remainder. Put the short piece aside, and go on drawing the rest down until it has been through hole 65, and now cut off 3 feet from that. Similarly, cut off 3 feet again when the wire has passed through hole 69, and the same after holes 73, 76, 80 and 86, and take what is left on until it has passed through the smallest hole, filing the point again whenever necessary. If the wire breaks, that shows that it requires *annealing*, or softening, and the way in which that is done is fully explained in the next chapter. But sometimes wire will break during the process of drawing down, merely because it has been sharply bent or twisted just at one point, so it may be better to go on until it breaks a second time. Silver wire may be drawn down until its original length has been multiplied many times without any annealing.

Sometimes when the wire breaks a small bit of it is left in the hole in the drawplate. This bit can generally be driven out with a needle, the tip of whose point has been broken off so as to convert it into a tiny flat-ended punch.

The various lengths that have been cut off make a total of 20 feet, but there should still be 3 feet left, and after this piece has been drawn through the last hole (90), it will have extended to about twice that length, for wire lengthens rapidly when it is drawn out fine.

To make the pointing of the wire a less difficult and worrying job than it would otherwise be, it is a good plan to hold it in pin tongs (Fig. 19, M), only allowing as much of the wire to project from the jaws of the tongs as you intend to file, and make a very slight nick across the edge of a scrap of wood, so that when the latter is held in the vice the nick you have made, when the wire is laid in it, prevents the wire from rolling about while it is being filed. Naturally, the nick must be so shallow that about half the thickness of the wire remains outside of it. Then, while you use the file, you rotate the pin tongs in which the wire is held, so that the tapered end of the wire may be kept approximately circular in section.

CHAPTER IX

ANNEALING AND COILING WIRE

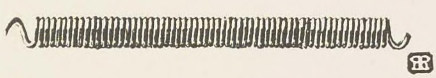
INCLUDING what remains of the original supply, you now have a small stock in nine different thicknesses, but the wire has been made hard by the process of drawing, and in order to wind it up easily into small spiral coils (as illustrated on p. 43), you must now soften it. This is done by heating it with a *soft* flame from a blowpipe until it is faintly red, but if you attempt to do this while the wire is lying loose you would be pretty certain to melt it, especially in the case of the finer sizes.

In order to avoid any risk of that kind, each length of wire must first be wound round the fingers into a hank measuring about 2 inches in diameter, and care must be taken that it all lies closely together. When you have got one piece neatly wound up, bind it with a short length of iron binding wire, so that it forms a compact ring with no loose ends or loops. In Fig. 13 a hank of thin wire is shown on the charcoal block (O) bound ready for softening, but the hank of thicker wire shown in Fig. 17 explains the idea better. Now heat your hank of wire with the *soft* blowpipe flame as described on p. 34, on the charcoal block or on the soldering wig illustrated on p. 33, until it shows a *faint* redness, and be sure that it is evenly heated all round and all through.*

* When doing this for the first time, it is a wise precaution to do it behind a screen, so that the silver may be in shadow. Otherwise you may not perceive the change of colour in time to avoid melting the wire. Perhaps the safest way of all is to blacken the silver all over with a smoky flame first, and then to heat it with the blowpipe flame until all the black disappears, leaving the surface of the silver pearly white. As soon as the black has all completely disappeared the silver is soft.

It is not necessary that it should be red-hot everywhere at the same moment, but unless it is heated to about the same degree in every part, it will not be evenly softened. This is called *annealing*. Treat all the pieces you have drawn down in the same way, and then cool them in water and unwind and remove the binding wire. The silver wire, which, when you coiled it round, was very springy, will now have no tendency at all to unwind itself. The next process is to wind the wire round steel rods, so as to obtain small coils;

FIG. 17.—A hank of wire, secured with iron binding wire, ready for annealing.



but if this is done without taking a necessary precaution, it would be almost impossible to get the coil off the rod when wound tight and close, as it should be. First, therefore, cut some narrow strips of paper—ordinary MS. paper will do—but it must be thin and tough. The strips should be about $\frac{1}{4}$ inch wide, and 6 or 8 inches long. Moisten one of these and wrap it spirally round the largest steel rod,* No. 40 (I.S.G. No. 12, easy). To do this properly requires a little practice, as the wrapping must be close and quite smooth, and the edges must not overlap too far, or else there will be too much thickness of paper.

Let the turns of the spiral be from right to left. The easiest way is to place the moistened strip of paper A on the palm of the left hand, with the end resting on the first finger. Put the end of the steel rod B down on the corner of the paper, so that the angle between the rod and the strip of paper is about 30 degrees. Then roll the rod on the paper between finger and thumb, backwards and forwards, until the paper begins to wrap itself round the rod, and

* Useful sizes for these are given at the end of this chapter.

continue the spiral wrapping until 3 or 4 incnes of the rod are covered, when it can be kept fast with a few turns of fine iron binding wire,* and the loose end of the paper can be torn off.

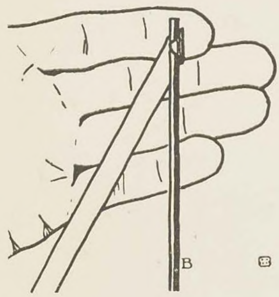


FIG. 18.—Wrapping a strip of paper round a steel rod.

Now curl the end of your No. 18 (I.S.G.) silver wire with the round-nosed pliers (Fig. 19, H) until the curled part will only just slip over the end of the rod where it is covered with paper. The silver wire must be curled from right to left, in the same way as the paper, and when the end has been started with the round-nosed pliers as described, and slipped on to the steel rod, they must be gripped together with the big flat-nosed pliers (Fig. 19, D) and turned round while the loose part of the silver wire is held tight, so that a few turns of this are made round the rod. These will now keep together while secured in the universal holder (Fig. 19, L), if you have one; or if not, in a hand vice (Fig. 19, E); or failing that, in a pair of clams (Fig. 19, A).

The steel wire generally used as a core for making coils is sold in 12-inch lengths, and its thickness is measured by the twist-drill steel wire gauge (Fig. 15, F), the size of each wire being indicated by the number of that hole in the gauge into which it fits.

The sizes required for this exercise are Nos. 40, 46, 50, 54, and 58. See Note D, Table II.

* See Note A, p. xxxvi.

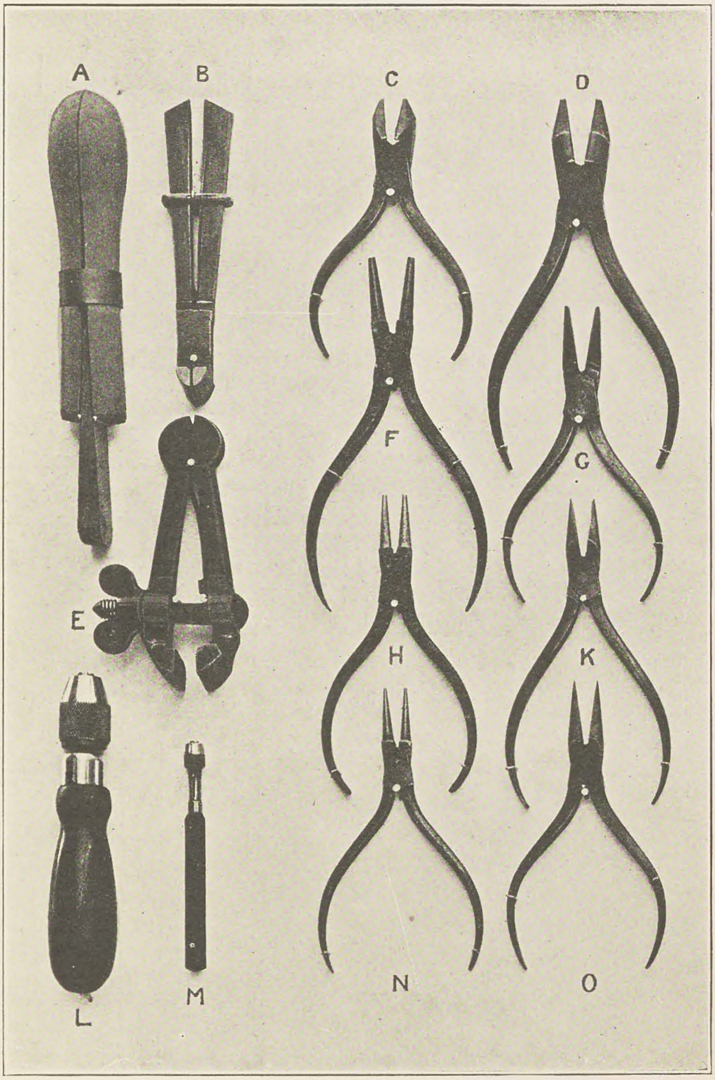


FIG. 19.—A. Wooden clams. B. Lancashire slide tongs. C. Skew nippers. D. Tapered bell pliers. E. Hand vice. G. Smooth flat pliers K. Snipe-nosed pliers (blunted). O. Snipe-nosed pliers (pointed). L. Universal holder. M. Pin tongs. F. H. N. Round-nosed pliers, three sizes.

CHAPTER X

MORE ABOUT COILING WIRE

It will now be an easy matter to complete the coiling, with the universal holder (or substitute) in the right hand and the wire in the left. The reason for coiling the wire from right to left will now be apparent, because it permits the rod to be turned in the easy and natural way; that is to say, from left to right. There is also another important reason, which is, that the chuck of the universal holder is, in consequence, kept screwed up tight, whereas if the winding was done in the opposite direction, the chuck would always be coming unscrewed. If the paper also had not been wound on from right to left, it, too, would now have had a constant tendency to unwind and get loose.

In order that you may be able to wind it tightly round the steel rod, the wire must be kept well strained, and this cannot be done without something firm to pull against. A simple and efficient arrangement is provided by an ordinary *smooth* brass cup hook, of the kind from which cups hang in a well-ordered china cupboard. This hook is screwed firmly into the edge of the table or bench just in front of where you sit. The pressure of the hook must *not* come against the paper wrapping, but against the last few turns of the silver wire which have already been wound around the steel rod. The rod with the wire coiled round it rests *across* the hook on the side farthest from you. Then, as the coil advances, it can be supported all the time by the cup hook just below the straight part of the wire, which latter is held in the left hand,

by which it is kept tightly strained. All that the right hand has to do is to turn the rod round and round, so as to continue the coiling.

The value of this arrangement will be appreciated fully when the smaller coils are made, for then the steel rod is itself only a very slender wire which is quite easily bent, and it is, therefore, unable to resist the pull necessary to stretch the silver wire tight, unless it is supported just where the

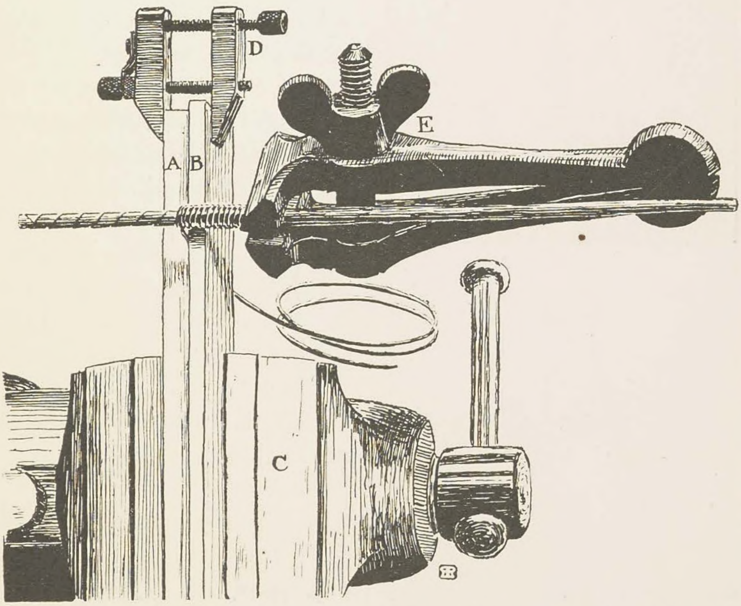


FIG. 20.—Winding wire into a coil around a steel rod. (Seen from above.)

pull comes. But some arrangement like the one which has just been described is equally necessary in the case of the larger sizes, too, for the thicker silver wire naturally requires a stronger pull to wind it closely round the steel rod. Care must, however, be taken not to strain the silver wire *too* tightly, especially when it is a thin wire, or else the paper wrapping will be cut through, and then there will be great difficulty in getting the coil to come off the rod. Fig. 20 shows another, more elaborate, but most efficient, way of

keeping a proper strain on the wire while at the same time giving a good support to the steel rod, and it is done as follows :—

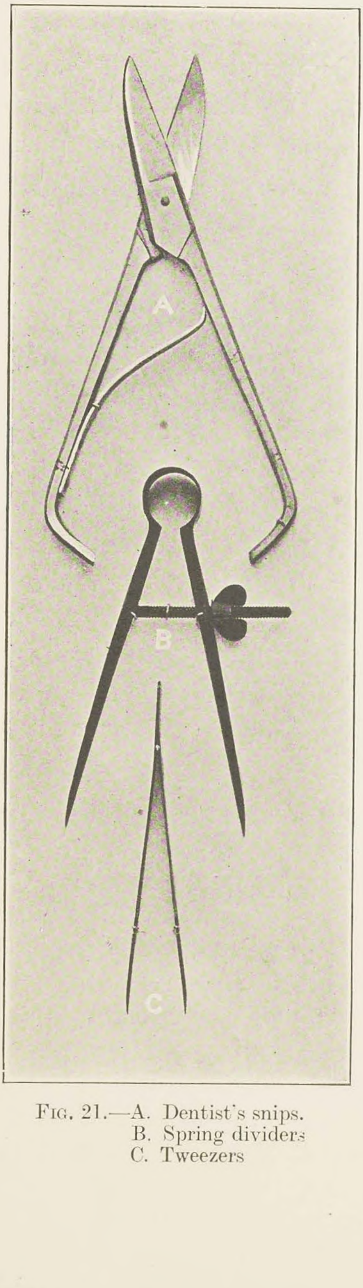


FIG. 21.—A. Dentist's snips.
B. Spring dividers
C. Tweezers

You pass the wire between two strips of wood, A, B, and then grip these together in the bench vice, C, so that when the steel rod is turned by means of the hand vice, E, while it rests on the top edge of B (which is kept a little higher than A, in order to prevent the paper wrapping from rubbing against A), then the wire is just able to squeeze its way through at the proper speed. The pressure with which the wire is gripped between the strips of wood, A, B, can be regulated to a nicety, either by a small clamp, D, or, failing that, by means of an ordinary screw passing through B into A.

If, however, you have no vice, then a little thought will show that these two pieces of wood (held together at one end by an ordinary screw, as just explained) could easily have their other ends fixed to the edge of the bench or work table by two other screws, so as to leave the parts through which the wire will pass projecting out from the right-hand side of the table.

The rings into which this first coil will presently be cut up are not likely to be wanted in large numbers, so it will not be necessary to make a long coil—$1\frac{1}{2}$ inches should do. When this is done, cut off the rest of the wire and anneal the coil you have just made, exactly as it is, on the rod. The paper will burn away, and now the coil will slip off quite easily.

Coils of all the other sizes of wire which you have drawn should now be made in the same way, care being taken to use a steel rod of the right size in each case, referring to the table (p. xlvii), in which the sizes of the silver wires and the

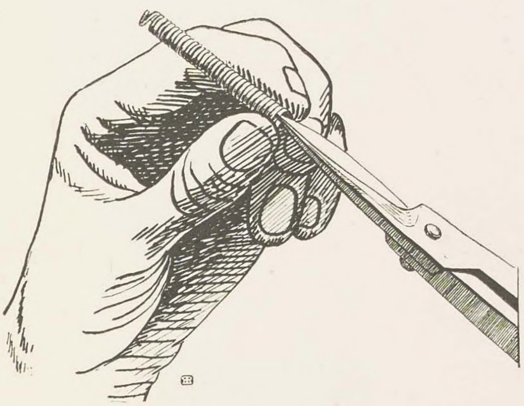


FIG. 22.—Cutting a coil of wire into rings with snips.

steel rods are given according to their plate or gauge numbers, and in decimals of an inch. It is much less confusing if both can be measured with the same gauge, and although the I.S.G. only gives an approximate indication of size, still, for merely making sure as to which is which, such measurement is near enough if a micrometer gauge (Fig. 15, D, p. 38) is not at hand.

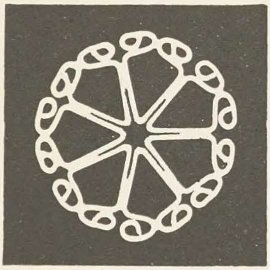
A short length of the second coil (No. 46 rod) will be enough—say, $1\frac{1}{2}$ inches, as the last—but from 2 to 3 inches had better be made of all the others.

When all the coils have been made, they must be cut up into rings, and the most accurate and reliable way of doing

this is with the piercing saw. That, however, is a rather slow and tedious job, and it is usual, when the rings are going to be melted into grains, to cut them with snips (Fig. 22), for if care be taken it is quite possible to cut them in that way with sufficient accuracy. The essential thing is to keep the flat side of one blade of the snips close against the end of wire left by the last cut, otherwise the part cut off the coil is likely to be less than a complete ring. Holding the coiled wire as shown in Fig. 22, and exerting a steady pressure by pushing against it with the thumb, you will easily feel when the end of the wire presses against the flat under side of the snips in the way it ought to do. For the sake of clearness, the coil and the snips which are shown in the illustration are both of them larger than would usually be likely in jewellery work, but the principle is just the same.

CHAPTER XI

MAKING SMALL RINGS AND GRAINS



When the rings are going to be soldered together *as rings* so as to form part of an ornament, they must be cut with the piercing saw, for if the snips are used, the cut ends will not be flat, and so the joints will be liable to show. A very fine saw should be used (No. 00), in order not to reduce the size of the ring unnecessarily, and in order, too, that the cuts may not be jagged, as they would be if a coarse saw was used.

For holding the coil firmly while the rings are being sawn apart, which is a troublesome matter, the beechwood clams are useful (Fig. 19, A). Take the wedge out of the clams, slip the coil in across one end, and put back the wedge at the other end, so that the coil is gripped securely, but not pinched out of shape. The clams can now be held firmly against the edge of the bench (steadied by the filing pin (Fig. 23), if you have one) while the coil is sawn down one side. But if you have got a bench vice, then the method shown in Fig. 24 is preferable and easier, and the boxwood clams with nut and screw are rather more convenient than the other pattern, where the pressure is exerted by means of a wedge. Whichever kind of clams you use, however, it is well to file a shallow half-round or V-shaped groove across each face of the clams, for the wire coil to lie in. It will then be held more securely and with less pressure than would be necessary if there were no grooves. Be very careful *not* to cut right through the

Fig. 23.—Board pin or filing pin.

coil to the other side, and as soon as you have cut through a few turns, pull away the rings with the tweezers, if they have not already fallen out of themselves. The board pin is fitted into a slot cut in the front edge of the bench, so

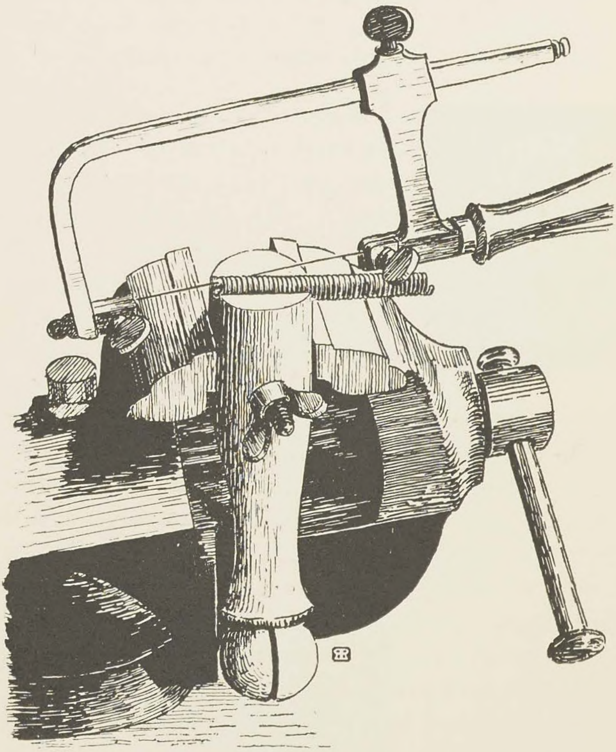


FIG. 24.—Cutting a coil of wire into rings with a piercing saw.

that the sloping end projects forwards at right angles with the bench (see Fig. 28, p. 77).

Take care to keep the rings separate according to their size. Small round tin boxes with glass lids, about $1\frac{1}{2}$ inches wide by $\frac{1}{2}$ inch deep, are very convenient, but pill boxes or match boxes will serve. But perhaps the most convenient arrangement is what is called a division box, *i.e.*, a shallow box divided up into a number of small square spaces.

Each box or division should have a label pasted on to it

with the sizes of silver wire, steel rod, of the ring itself, and of the grain resulting from this ring when melted. The small amount of time occupied in arranging and storing little things of this kind methodically is afterwards saved over and over again. Any pieces of coil not cut up into rings when made, should be kept in the same box with the rings cut from it, in order to save the trouble of measuring the next time it is wanted, for the difference in size between one coil and another is slight enough to make confusion very easy.

The coils made of wire numbered 20, 23, and 25 I.S.G. will be used for making grains, and these may be cut up with the snips (Fig. 22, p. 49), so long as due care is taken to cut the rings of the full exact size by keeping the cut end of the coil close to the flat side of one blade of the snips each time ; otherwise the rings will be slightly less in size than they should be, and then the grains will be sure to vary.

The snips must have sharp points, or they will not do for cutting up small coils. These, however, can often be cut quite well with a pair of ordinary *strong* nail scissors. Of course, the cutting up of coils with snips or scissors is more easily done if very fine wire is used, this being wound into coils of correspondingly larger diameter, and then there is also less danger of the rings varying in size ; but it is not so very easy to melt them into grains if the wire is very thin and the ring comparatively large. Not by any means that the thin wire does not melt easily, but that it is apt to divide and form into two or more grains, instead of only one, when the ring is comparatively large in diameter and is made of very thin wire.

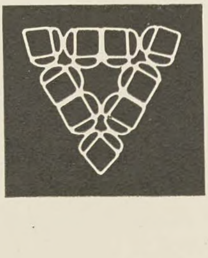
In order to make the grains as nearly spherical as possible, small hollows of the size of the grain are made in the charcoal block with a ball punch, and the rings, when melted, are caused to run into these. But if the ring is comparatively large, then, when melted into a grain, it is apt to run anywhere rather than into its own hollow. If grains are made on a flat surface of charcoal instead of in a hollow, the underneath side of the grain will be quite flat. Sometimes

this does not matter, or is even an advantage, as, for instance, when they are to be hammered in order to make discs ; but for making clusters it is very important that the grains should be as nearly as possible spherical, so that it may not matter which side is uppermost.

If you have not got ball punches of the right size for making the hollows in the charcoal block, these *can* be made with the grains themselves ; but then it is not very easy to regulate their depth, and if they are too deep they will not answer their purpose properly. The hollows should not be deeper than half the thickness of the grain. If they are made with a grain which has been melted on a flat surface, care must, of course, be taken to make the hollow by pressing the *rounded* side of the grain into the charcoal. The hollows should be about $\frac{3}{8}$ inch apart, and those for the different sizes of grains should be kept quite separate, a group of, say, twelve hollows for each size being neatly arranged in rows. But do not make a number of hollows until you have ascertained the right depth by experiment.

Use a *gentle* flame of moderate size for making grains, so as not to burn away your charcoal block unnecessarily, and remember that the silver should melt instantly when the inner tongue of flame touches it, and that a very little wind is all that is necessary to make the flame melt these small rings quickly. Probably it will appear to be a slow business at first, but, after a little practice, grains of medium size should be made at the rate of from 150 to 200 an hour, including the preliminary stage of making rings.

When making small grains with a Duresme blowpipe, I use a flame only about $\frac{1}{2}$ inch long.



CHAPTER XII

PICKLING AND SILVER SOLDERING

One result of melting standard silver is to turn the surface black, and before the grains can be soldered together they must be cleaned by immersion in "pickle," *i.e.*, weak acid. An old kitchen teaspoon * will be useful for this, especially if the handle is bent so that the bowl of the spoon will remain level when it is laid in a small vessel containing the pickle.

The vessel may be of fireproof earthenware, but those usually sold for the purpose are made of copper, and are called "boiling-out pans." The copper gets gradually corroded away by the acid, but, on the other hand, the fireproof earthenware vessels are liable to get broken, and they must not be exposed, as the copper ones may, to a strong, sudden heat; but a durable pan consists of a bowl of rather thin sheet lead used as an inner lining to any convenient metal pot.

For silver work the usual pickle is made of sulphuric acid (vitriol), and it must be handled carefully.† Any one who is beginning jewellery work only needs to have quite a small quantity at a time, say, 4 oz. or even less, and it should be kept in a stoppered bottle. Measure half a pint of water (10 fluid ounces), and pour *into* this about $\frac{1}{2}$ oz. of sulphuric acid, *i.e.*, 1 part acid to 20 parts water. This should be kept in a bottle labelled "Dilute Acid for Pickling."

* *N.B.*—Do not on any account use an *iron* spoon for this job.

† If any of the strong acid gets on the fingers, they must instantly be washed with plenty of clean water to avoid burns.

Remember particularly that the acid should be poured *into* the water ; *never* the other way round. The process of mixture generates heat rapidly, and even four teaspoonfuls of sulphuric acid will make half a pint of water warm when poured in, while if water were poured into the acid there would be an explosion which might even blind you.

Now put the old teaspoon containing the grains into the pickle, and they will soon get quite clean and white ; or, if the pickle is made hot, the cleaning will be almost instantaneous.

When the grains have been well rinsed in clean water to remove all traces of acid, they will be ready for soldering together.

You will now need some borax, either in the crystal or, if you can get it, in its compressed form, as sometimes sold for jewellers (Fig. 25, M) ; a piece of slate, or one of the rough stoneware saucers which are made for the purpose (Fig. 25, N) ; a small water-colour paint brush, and some silver solder.

N.B. There is an important little detail to remember in connection with " boiling out " and with the use of acid pickle generally, and that is to take care that no iron or steel gets into the pickle. If that does happen, it will set up galvanic action immediately, and that will cause a deposit of copper to occur on the surface of the silver or gold or brass, as the case may be, wherever the iron touches it, if not all over the surface—and when this takes place, it is sometimes difficult to remove, especially if there are deep nicks which are awkward to get at.

Consequently, when you want to boil out a bit of work, either suspend it from a bit of copper or brass or silver wire, or use a " dipping " basket or ladle ; or, when the job is small enough, the aforesaid old teaspoon. A small basket or ladle made of brass or copper gauze, attached to a ring and handle, will do excellently, and is easily enough made ; also, a pair of strong tweezers made of thick sheet brass will be good for some jobs.

Get the best quality *hard* silver solder, rolled fairly thin—

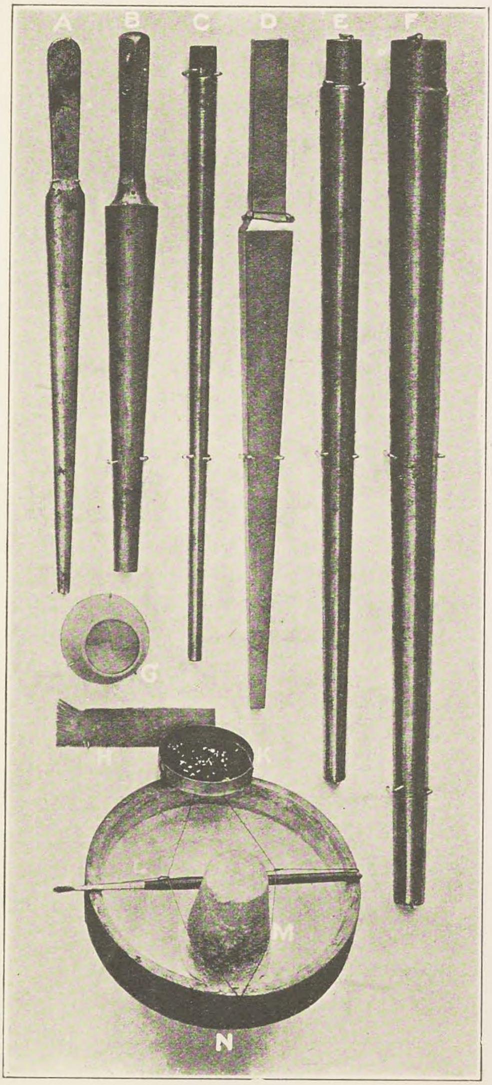


FIG. 25.—A. Thin oval triblet. B. Thick oval triblet. C. Small round triblet. D. Square triblet. E. Medium round triblet. F. Large round triblet. G. Eyeglass. H. Strip of silver solder showing method of cutting. K. Box lid containing solder cut up ready for use. L. Borax pencil. M. Compressed borax. N. Borax saucer.

say, No. 4 or 5, metal gauge, *i.e.*, equivalent to No. 28 or 30 I.S.G. Half an ounce of silver solder will last a good while. Cut off a strip about ½ inch wide, and cut a series of slits up one end of this, each slit being about $\frac{1}{32}$ inch from the next one, and let the slits extend as far up the strip as you can easily cut at one stroke (Fig. 25, H). Then cut across these slits close to the end of the strip, so as to obtain a number of minute oblong pieces of solder (Fig. 25, K).

In order to prevent these from being scattered about and lost as they are cut, the strip is held between the thumb and the side of the middle finger of the left hand in such a way that the end of the strip presses against the ball of the first finger of the same hand while the bits are being cut off, and after each stroke of the snips, all the bits which have been cut off are found lying on the ball of the first finger, from which they should be transferred to one of the boxes (Fig. 25, K) mentioned on p. 52.

It is better not to expose them to the air unnecessarily for any great length of time, as, if they become tarnished, they will not solder so easily or so surely.

Now take a piece of borax and, when you have moistened the slate with a little water, rub it with the borax until you have produced a white cream, which must still be fairly liquid. Take up some of this with the brush and apply it to the grains where they are to be soldered together. This will presently help the solder to melt and to unite with the silver, acting as a flux, preventing oxidation of the surface of the metal, and, in the meantime, keeping the grains in contact.

Now take up one of the little bits of solder on the tip of the brush, which is just moistened with borax water, and transfer it to the nick formed by the two grains where they touch each other. Touch it again with the borax brush, so that it may have a coating of borax water all over it, and all is now ready for the flame.

Apply the heat gradually, because if the moisture is evaporated too rapidly the solder is likely to be displaced; but if this should happen, moisten the solder again and put

it back into the nick. It is a good plan to put the work aside to dry, after charging it with solder, while preparing the next part.*

The grains must now be heated on the side furthest from where the solder is, because the solder will get hot much quicker than the grains, owing to its being such a minute thin fragment, and if it is made ready to melt before the surrounding parts have reached the same temperature which the solder has attained, it will melt into a round grain, sticking, perhaps, to one or other of the larger parts, but not uniting them. The heat, therefore, should be conveyed to the solder *through* the parts which are to be united. This is also desirable for another reason. When solder melts, it will always have a tendency to run *in the direction of any adjoining part which is hotter than itself.* When no adjoining part is hotter or hot enough, it will, as I have just said, gather itself together into a round grain. Therefore, the thing to aim at is to make the parts which are to be united hotter than any other place, so that, when they are hot enough to cause the solder to melt, it will have a natural tendency to run in between them and unite them.

From what has been said it will be evident that, if one of the grains is allowed to get hotter than the other, the solder, when it melts, will be likely to spread itself over the hotter one without reaching the other at all.

It is very important to remember *that,* whatever it is that you are soldering.

The process of soldering should never be hurried, but, on the other hand, the heat should be got without unnecessary delay. The surface of the charcoal block will get red

* At one time a soldering fluid called Fluoron was sold, and this was nice to use, as with it the particles of solder remained still, whereas with borax and other fluxes they are very frequently displaced. But Fluoron appears at the time of writing to be unobtainable. When using borax, if the heat is removed as soon as the borax begins to expand, the latter will often carry the solder back to its proper place with it as it subsides.

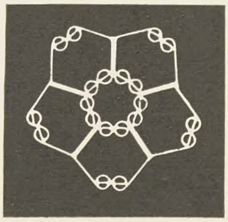
But if some *sandiver* is mixed with the borax water, as recommended in the "Goldsmiths' Handbook," by George E. Gee, the bits of solder will not be displaced. Sandiver is not very easy to obtain, but it is merely the impure glass which is skimmed off from the top of the pot in which glass has been made. It is ground to a fine powder. The exact amount added to the borax water does not matter.

immediately, and the heat that is reflected from this is most useful.

Although this next point has already been mentioned in Chapter VII., it is necessary to repeat here that it is important to keep up a certain amount of movement, either of the flame itself or of the charcoal block on which the work is resting, all the time. That reduces the likelihood of one part being accidentally heated more than the rest, and, likewise, it provides against the danger of any parts being allowed to remain cold. If the latter did happen, these parts might perhaps draw off some of the heat from the parts to be united just at the critical moment. No doubt that is rather like saying the same thing in two slightly different ways, but it is not *quite* the same. *Over*heating of parts generally means that too fierce a flame has been used, while *under*heating of parts probably results from the flame being too feeble. But either fault may equally well be due to omitting to maintain that constant movement.

The warning against allowing any part of the work to remain cold applies especially when using silver solder for uniting pieces of copper, because of the high conductivity of that metal. Keep it warm *all over*.

In cases where the bits of solder are unavoidably liable to catch the heat of the flame too soon, then, as soon as they are beginning to get too hot, they must be given time to cool a little by moving the flame off them for a second. Some of the heat is drawn from them by the natural attraction of the larger pieces of metal which are in contact with them, after which they may be exposed to the flame again.



CHAPTER XIII

MORE ABOUT SILVER SOLDERING

It is well to try and understand the reasons of the things discussed in the last chapter from the beginning, even if much of their application will only come with more advanced work, because each scrap of knowledge of this kind makes it easier to account for the failures which must occur at first, and an understanding of the probable causes of failure makes the accompanying discouragement much less trying. Moreover, with these ideas in the mind, a habit will be implanted of steering clear of dangers unconsciously, and that will be especially valuable later on, when in more complicated work there are many other things to be watched and remembered at the same time.

In connection with the use of silver solder another point should be mentioned here. The small proportion of brass which it contains, in order to enable it to melt at a lower temperature than standard silver, is injuriously affected by long exposure to heat ; for brass is a mixture of copper and zinc, and zinc is a volatile metal, that is to say, it vaporises into gas and burns away when a certain temperature is reached and maintained long enough. If this is allowed to happen, the solder will no longer melt at its proper temperature, and that is why, if the solder begins to glow with heat before the surrounding parts are hot enough, it must—instantly—be given a second or two to cool a little. Also, minute traces of lead, which are often found in silver solder,

have an objectionable power of eating away any silver with which the solder remains in contact at a high temperature.

In order to prove this, put a bit of solder on a silver grain and melt the *solder* very slowly by heating it gradually to a dull red, so as to expose it to this heat for a minute or two before bringing the temperature up to the actual melting point of the solder. Afterwards clean the grain in the hot pickle, and you will probably find that the solder has eaten away a little hollow in the silver. Similarly, if a joint which has been silver soldered is afterwards exposed to the action of the blowpipe flame *too much*, while other joints are being made near it, it will become spongy or porous, owing to the formation of tiny holes where particles of zinc have been burnt away.

Apart from being careful not to continue the heat too long, it is not difficult to avoid this last trouble. The previously-made joint should be painted with borax water, and then the solder will " flush " or " run " again, and be uninjured. When taking this precaution, it may be well to see that all such joints show up white when the moisture has evaporated, because this proves that enough borax is present.

Some jewellers use a thick paste of rouge, or of tripoli, or of whitening, or of loam and water, to protect previously-made joints, and so long as a sufficiently thick coating is applied, that will certainly prevent the old solder from being melted or " burnt," but there is some danger of the surface of the silver being discoloured.

Parts which have been once properly united with silver solder are not very liable to drop apart again simply by their own weight, unless the work is heated a good deal more intensely than it should be. Little bits of charcoal and of pumice stone may be used to support any parts that seem to need it.

Any beginner who has read through these somewhat detailed recommendations which are connected with the use of the blowpipe flame and of silver solder may—not altogether without reason, perhaps—feel rather bewildered with such a multiplicity of directions and cautions, and he is not

recommended to do more than just read through these parts fairly quickly at this stage. But if he does that much now, then afterwards, when difficulties and failures occur, as they must inevitably do, at times, he will perhaps have a vague recollection that there was something in what he read before which had a bearing upon the difficulty he has just encountered, and that will be the right time at which to read these passages over again, and more carefully, in the light of his later experience. The index at the end of the book should make it quite an easy matter to turn up any particular passage of whose existence he has perhaps been reminded by the difficulty which he has encountered, though he is unable to remember just exactly where to find the passage about which he would like to refresh his memory.

To return, then, to the first exercise in soldering, namely, that of uniting two grains.

As soon as this has been accomplished successfully, it should be repeated at least a dozen times immediately. Then try and add a third grain to some of the pairs which you have just made. You will probably find, when you try to do it, that the third grain will sometimes get united to *one* only of the other two, instead of to both.

A close examination of Fig. 1, p. 2 (especially if you look at it through a magnifying glass), will show you that this has happened in several of the clusters, and that the appearance of those particular clusters is thereby considerably spoilt. The last cluster but one in the top row illustrates this point clearly. In this group the four grains ought to form a perfectly symmetrical lozenge shape, but the solder which unites the lowest grain to the others has run all to one side, and has *carried the grain with it*, so that it leaves an ugly open joint on the other side and disturbs the symmetry of the arrangement. This and the many other similar defects in the other clusters which are shown in that illustration resulted simply from hurrying the process of soldering, in consequence of which the grains were not all of them evenly heated *at the moment* when the solder melted—that is the essential point.

In a series of examples like those illustrated in Figs. 1 and 2 these defects are not of any serious consequence ; they are, indeed, useful as object lessons of things that must be avoided ; but in ornaments that are intended to be finished and sold, or perhaps to be given to some one whose judgment is valued, such defects would not only be a constant eyesore to the owner of the ornament, after they had once been detected, but they would also seriously impair the strength of the object.

Thus each grain needs to be quite perfectly united to all other grains or parts with which it may be in contact, so that there may be no weak places anywhere. To unite all the grains or other parts is not so very difficult, but it *is* rather difficult to do it quite *perfectly*—that is to say, to make the connection of all of them really secure—without using an undue amount of solder, and that is one reason why the solder is cut into such tiny pieces. The size and thickness of these little pieces must vary considerably according to the thickness and the size of the objects which have to be united, and if there is a considerable bulk and weight of silver that has all got to be heated through, then the strips of solder which you cut up for use on that particular job must be correspondingly thick, so that the pieces may not melt *too* quickly, as they would be likely to do if they had been cut from a strip of thin solder. However, in these first exercises we are dealing with small objects, and some of them are very small indeed ; and as the tendency of beginners is generally in the direction of using too much solder, it will be well to aim at using no more than the very smallest quantity which will suffice to unite the parts together properly.

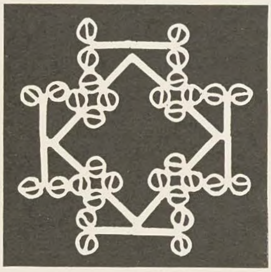
When a few of the twin clusters have been successfully converted into triple ones, by the addition of a third grain to each pair, the next stage is to learn how to make triple clusters *at one firing*. To do this, moisten three separate grains with borax water, so that they will remain in close contact with each other on the charcoal block, and place a somewhat larger bit of solder than those you have hitherto been using in the hollow at the centre of the cluster. Now

dry up the moisture very carefully by slowly warming the job, and then direct a gentle, silent flame, as nearly as possible vertically, downwards on to the cluster in such a way that all three of the grains are entirely enveloped in flame. Watch the solder carefully, to see that it does not get heated too quickly—that is to say, the solder must not get heated *more* quickly than the grains themselves—and keep up a slight movement either of the flame or else of the charcoal block which supports the job itself. This is done in order to make sure the three grains shall all be heated to the same extent.

When the solder melts, it ought to spread itself evenly into all three of the joints between the three grains, and it ought to unite them together quite securely. If it does *not* do so, it must be for one of the following reasons :—(i.) the amount of solder used may not have been sufficient ; (ii.) the solder may have been displaced by the evaporation and expansion of the borax water ; (iii.) the grains may have become slightly separated by this same cause ; (iv.) the heat may have been too sudden ; or (v.) it may have been unevenly distributed ; or (vi.) it may have been too slow, causing the solder to perish ; or (vii.) you may have forgotten to keep up that slight movement while getting up your heat. (See also remarks about uniting copper units with silver solder, p. 60.)

CHAPTER XIV

DEVICES FOR MAKING CLUSTERS OF GRAINS



A FEW trials will probably enable you to see which of the reasons given in the previous chapter accounts for any failures you may have, and a few more should enable you to avoid failure, when once you have determined its cause. Don't be satisfied until you have made at least a dozen clusters of three grains quite perfectly. You will very soon use them all up and wish you had made lots more. All other clusters or groups are best made from groups of two or three, previously soldered together, with the addition of single grains afterwards where required ; for more than three grains are not easily united *at a single* soldering in any required arrangement. They have a way of moving into different arrangements quite of their own accord just when the solder is in the act of melting. They will even sometimes roll round each other and mount up into a pyramid, by force of capillary attraction, if the flame is kept on them a moment too long. But when a large group is constructed by first of all making up a sufficient number of twin or triple clusters, it is then only a case of soldering these clusters together, and so there is no great difficulty in avoiding such troubles. It is, however, important to remember always to paint the previously-made soldered joints with borax water before uniting various parts with more solder, so as to avoid the risk of burning the solder in the first joints (as described on pp. 61, 62).

The cluster in the middle of Fig. 1, formed by three triple clusters, leaving a hole in the middle, and the last example in the same plate, which is made up of seven triple clusters, are both quite easily made in those

A

two stages, but it would be extremely difficult to make either of them at one soldering. Again, even the group of four grains  in the middle of the top row in the same plate, which looks so very simple, is not by any means easy to make in one soldering, though it comes readily enough when two previously soldered pairs are placed alongside and are then united into one cluster.

Small rings of grains, such as those in the second and third rows, are also best made out of a number of twin clusters, with the addition of one single grain where odd numbers are to be used. If such an arrangement requires the use of a good many twin clusters, it is wisest to make a shallow circular groove in the surface of the charcoal block, either with dividers or with a ring punch, but only just deep enough to keep the grains in their proper relative positions, and to prevent them from rolling about. Such a groove is not likely to be of *exactly* the right size to take the precise number of grains that are to be used, without leaving any space over, but that does not matter so long as the space that is left is not considerable.

All the pairs are soldered together except where the space is left, and when they are cool this space is closed up by carefully bending the ends of the string of beads together, after which the last joint is soldered. Similarly, if the groove is slightly too small, so that a grain has to be omitted, one open space is left, and after all the other places have been soldered this space is gently widened until there is just room enough for the last grain to be pressed into its place, where it is then secured by soldering. As a matter of fact, large rings of beads are usually made of beaded wire, as described on p. 21, but the above method is useful for smallish rings composed of comparatively large beads,

when the rings are still too large to be made passably true without some guide to keep the grains in the right curves.

The clusters of grains in Fig. 2, p. 4, are, all of them, first made as in Fig. 1, and then smaller grains are soldered to these groups, either singly or in twos, threes, or other arrangements, as may be required. The methods employed are, for the most part, those already described, but where clusters of grains of *varying* sizes are soldered together, it must be done in a slightly different way.

In such cases it is generally desired that the large grains should stand up above the smaller ones, *i.e.*, that the grains should all be about level at the back, or else the large ones should project beyond the small ones equally before and behind. Whichever effect is desired, it is best to do the soldering in this case, as, indeed, in almost all cases, from the back ; and so, when the cluster of large grains has been made and cleaned ready for the addition of the small groups, it is pressed down a little way into the charcoal block with the flat end of the tweezers until the small clusters, when laid against it on the charcoal, will touch the large grains at the right level.

This method of pressing the work down until it is partially embedded in the charcoal is also sometimes useful for keeping several small parts in place during soldering, but, unless they are very small, trouble ensues from the expansion of the metal when heated, because the charcoal does *not* expand, and so the metal becomes too large to remain in the hollow which contained it when it was cold. Consequently, it rises up, and the arrangement may be completely disturbed, and all the little bits of solder will then most probably have been displaced.

The next stage consists in making clusters like those shown in Fig. 3, p. 8, and in order to do this some of the large grains are hammered flat. A few sharp strokes of the hammer while the grain rests on the polished surface of the flat steel stake (Fig. 26, B, p. 72) are all that is necessary. Take care, however, not to hit the stake itself with the edge of the hammer, or it will get dented, and any such marks

will be reproduced on the silver discs themselves if they happen to be lying on the dents when struck.

The face of the hammer should be parallel with that of the stake when the grains are struck, so that the upper and under surfaces of the discs (into which the grains are converted) may also be parallel. A disc whose surface slopes down to one side never looks well. Also, such a disc is not likely to be truly circular in outline, as the sloping surface proves that one side has been made to bulge out unduly by being hammered more than the other parts.

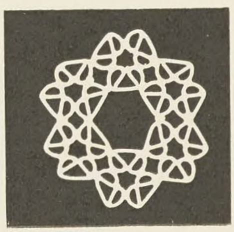
If the discs show a tendency to split at their edges while being hammered down, as they will do sometimes, this shows that they will not stand so much hammering without an intermediate stage of annealing. If this annealing is done *before* any sign of a split appears, the hammering may be continued so as to increase the size of the disc, while at the same time its thickness is still further diminished.

It is by no means easy to solder the edges of these discs together without allowing any of the solder to " flush " on to the flat tops, which seem to have a peculiarly strong attraction for the melted solder. However, if the precautions given in Chapter XII. are observed, it is simply a question of care and practice ; but it is best to solder from behind whenever possible, and for this reason the discs should be examined before they are soldered, in case they look better on one side than on the other. Then, provided that the best surface is always turned downwards, it will not matter *so much* if the solder does happen to spread over the upper surfaces of some of the discs, because these surfaces will eventually be at the back.

When solder does flush over a conspicuous surface, it has to be carefully scraped off or otherwise removed afterwards, especially if the surface it has covered is plain and smooth, because any such part over which the solder had flushed would show an unpleasant surface of a greyish colour ; and if the solder was allowed to remain, it would always appear as a blemish.

When a disc is to be soldered on to the top of a cluster

as the centre of a small group, for example, it is best to melt a little solder on to one of its flat surfaces, so that the solder spreads out nearly all over that surface. Then put some fresh borax water on to it and place it where it is desired to fix it, with the soldered face turned downwards, and warm the whole mass carefully, *keeping the heat off the disc itself* as much as possible, or else the solder on this will not adhere to the parts below. The lower parts must be made the hottest, so that they may draw the solder down when it melts.



CHAPTER XV

MAKING DISCS, DOMES AND RINGS

For making thin discs, circular steel cutting punches (Fig. 26, A) will be required, and some sheet silver, and something to punch it on. The best thing for this purpose is a cake of rather hard lead or of zinc or bronze, which should not be less than $\frac{1}{2}$ inch thick—preferably twice that thickness; about 3 inches × 3 inches × 1 inch is a handy size. But such a cake of metal has to be specially cast for the purpose, and, though it is convenient to have one, yet, for punching a few small discs such as are now required, all that is necessary is to protect the surface of the steel stake with an old halfpenny which has got worn quite smooth, the coin being laid down on the stake with a pinch of modelling wax between in order to keep it from moving about. On this discs can be cut perfectly well, even out of comparatively thick sheet silver, if required; and as "coppers" are really made of very hard bronze, one will last a long time. If the edges of discs which have been cut in this way appear ragged, then use a bit of sheet lead over the coin. A scrap of "compo" gas pipe hammered flat will do well. It is harder than lead.

The steel stake itself, though very frequently wanted, is not absolutely necessary if an old flat-iron can be found. This will make a good substitute if it is mounted between two stout pieces of wood of equal width, rather broader than the projection of the handle of the iron and about the same length as the iron itself. They should be fixed together by a couple of long screws or, better still, bolts, so that one

board is on each side of the handle of the iron, which is thus supported between them on their edges, with its bottom turned upwards. If this surface is not bright rub it well with fine emery cloth.

Any fairly solid piece of iron or steel will do for hammering grains, etc., upon, so long as it has a smooth, flat surface which, with a bit of fine emery cloth, can soon be polished.

Where it is an object to minimise noise, the stake should be laid on a leather sandbag (Fig. 27, B) or on some loose sand in a box or tray, or even on a thick pad of folded

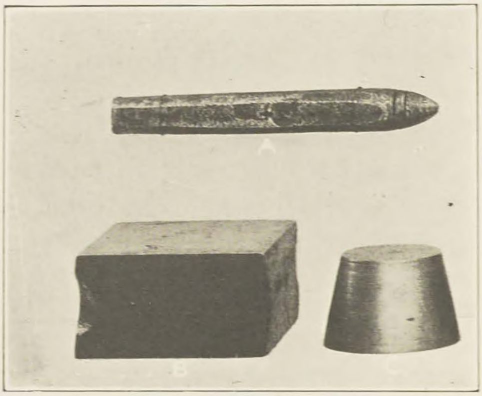


FIG. 26.—A. Round cutting punch. B. Flat stake (or board steady). C. Cup- (or bell-) pattern Troy weight used as a triblet for setting rings true.

newspapers, by which means the sound is effectively deadened and greatly mitigated.

"Straw pads," made of corrugated straw board coiled up into mats, are also sold for this purpose.

Here it is perhaps necessary to say that the small silversmith's hammer, which ought to have a perfectly smooth and brightly polished face, must *never* be used for striking steel punches, unless with the side. Any ordinary hammer will do, and is all the better for being rather heavy. A big *repoussé* hammer is, perhaps, the most convenient, if you happen to have one (Fig. 29, E, p. 78). It is best to give the punch a number of rather light taps, taking good care

to hold it firmly in one place, but swaying it slightly, first to one side and then to another, so that, after a circular mark has been made, the actual cutting through is done, as it were, bit by bit, rather than all the way round at once. In this way you will get what is called a shearing cut.

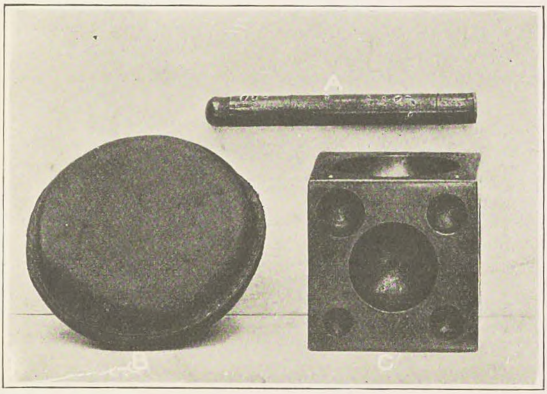


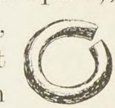
FIG. 27.—A. Doming punch. B. Sandbag. C. Doming block.

In order to convert the discs into domes or cups they are laid, one at a time, in a hollow in the doming block (Fig. 27, C), into which they will just drop fairly easily, and they are then driven down into the hollow with the hammer and a ball-faced or doming punch of suitable size. A large doming block is rather expensive, but a jeweller very rarely needs the large hollows, and if the block has only small hollows its cost is very much reduced. Moreover, thin discs can be domed quite well in hollows made with hammer and punch in a cake of lead (Fig. 29, N, p. 78), or even a piece of wood, if it is pretty hard.

Assuming, then, that a fairly complete stock of all these different circular forms has been prepared, each form being repeated in a considerable variety of sizes, the next step will consist in uniting some of them into pairs and triplets in order to facilitate the composition of designs by experimental arrangements.

In dealing with the rings, each one must first be carefully

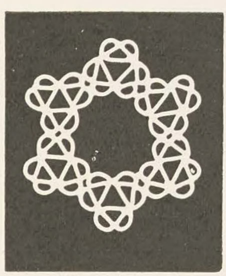
"set," so that its ends are brought close together until they press against each other, care being, of course, taken to preserve the perfect circle of each ring. In the case of the smaller ones, a plan that answers very well is to put them on the flat stake and press them down, one by one, with the broad flat part of the tweezers until the ends of each ring are in one plane (when cut off the coil, each ring formed part of a spiral), and then to close the ends together, gently but firmly, with the snipe-nosed pliers. But the closing must be done by giving the ring a slight squeeze with the pliers, first across one way and then across the reverse way, for otherwise it will be liable to get crushed out of shape. If it once begins to lose its circular form, it will yield suddenly to the pressure of the pliers and double up and be wasted.



The larger sized rings should be closed by gripping them near their cut ends with two pairs of snipe-nosed pliers, by means of which the ends are easily brought together in the same plane. All those rings which are to be reserved for use singly must have their joints soldered at this stage ; but great care must be taken not to use more solder than will just fill the joint nicely. If there is too much solder, it will, of course, make that part of the ring thicker than it ought to be, and will spoil its shape. The solder *can* be filed or cut away, but that is troublesome, and the effect will not be nearly so good as if the amount which is used is only just sufficient. When the soldering is done, a further element of variety may be obtained by lightly hammering some of the rings on the flat stake, so as to make their upper and under surfaces flat.

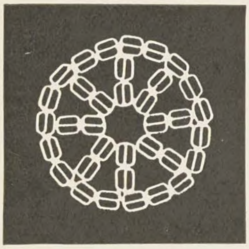
In the illustrations of ornaments constructed out of circular forms (Figs. 5, 6, 9, pp. 13, 14, 19), some of the rings are larger in diameter than admits of their being conveniently made by coiling a length of wire round a steel rod, as described on p. 44. Theoretically, there is no limit to the size of rings which can be made in this way, though for any except the small sizes already treated of, *steel* rods

are not essential, tubes of brass, copper, or iron being nearly as good ; but the jeweller does not, as a rule, want enough of these larger rings for it to be worth his while to make many of them at once, or to keep such a variety of rods or tubes as would be necessary to meet every emergency.



CHAPTER XVI

MAKING AND SETTING LARGER RINGS



When a few rings (say, for example, not more than two or three) are wanted of a size larger than the little ones whose production has already been described, the usual method is to bend a piece of wire with the pliers or, if it is large enough, with the fingers, so as to ascertain the exact length necessary for the required ring; then to cut this off, to file the two ends flat and solder them together; and to leave the final perfecting of the circular form until after this has been done. This final adjustment of shape is called "setting" or "truing," and in order to set rings of varying sizes, most jewellers have several tapered mandrels or triblets (Fig. 25, A to F, p. 57).

One of the objects, however, of these elementary technical chapters is to enable beginners to learn how to make simple ornaments with the most limited and inexpensive outfit of tools, and tapered mandrels or triblets are rather costly.

One small triblet is almost necessary, but for those who must observe strict economy it is generally possible in a town of any size to pick up a few second-hand cotton-spinners' spindles for a trifling sum, and they will serve very well. These and many other most useful odds and ends can often be found on the barrows of hawkers who ply a trade in tools in the poorer quarters of most big towns on Saturday nights. An old steel "heckler's tooth," though less often found, is also very handy to a jeweller. It is simply a piece of the best round steel squared at the butt end, and evenly tapered down to a fine point, the total length varying from 5 to 9 inches (Fig. 13, K, p. 33).

In order to "set" a ring true after it has been soldered, it is slipped on to the triblet (or substitute) as far as it will go, and this is then laid flat on the bench so that the butt end, which is held in the left hand, projects over the edge of the bench from the place where the ring binds. The ring is thus pressed against the edge of the bench while the triblet is revolved, and the ring is tapped with a hammer or mallet and encouraged to slide along the triblet until it fits

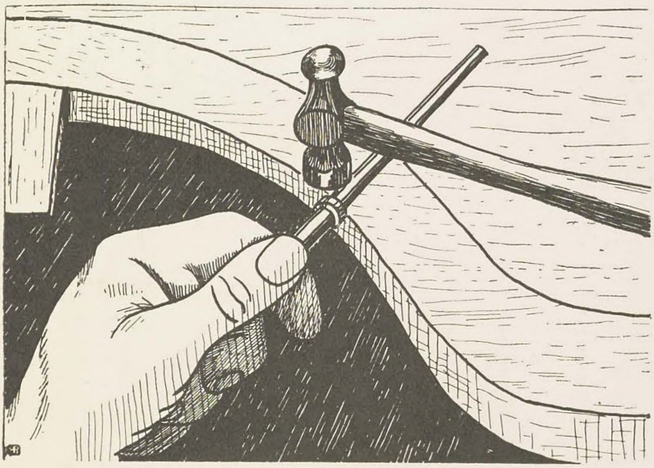


FIG. 28.—Setting a ring true on a triblet, which is held across the edge of a jeweller's bench.

this closely all round (Fig. 28). It is then truly circular, and is slipped off.

If you want to "set" a ring which is larger than your triblet, there are various substitutes. Perhaps you may have a sparrowhawk, which is a sort of miniature smith's anvil, made as small as 4 or 5 inches long (Fig. 29, K). One end of this is roughly tapered round, and although the ring will not fit it like it does the triblet, it *can* be set true by tapping it while it is slowly revolved at the place where the curve of the sparrowhawk is the same as that of the required circle. Bell-shaped Troy weights (Fig. 26, C, p. 72) are also very useful. Failing either of these, you may find it possible to make shift with the handle of a pair of pliers

or some other tool, but for a ring measuring, say, $\frac{3}{4}$ inch or more in diameter, a more reliable method is to spring it on to a disc of sheet brass or copper or iron, and anneal both together, after which the ring will retain its circular form

Fig. 29.—A. Sliding callipers, or slide gauge. B. Steel square. C. Straight steel burnisher. D. Small *repoussé* (or chaser's hammer). E. Large *repoussé* (or chaser's) hammer. F. Jeweller's hammer. G. Jeweller's piercing saw. H. Spitsticker. K. Sparrowhawk. L. Bullsticker. M. Flat scorper. N. Lead cake. O. Horn mallet.

when taken off the disc. Halfpennies, pennies, and washers are all useful for this purpose, or you can strike a circle of the required size on a piece of fairly thick sheet brass, and afterwards cut and file it to this line.

This method is very useful for other shapes, such as ovals,

heart shapes, etc., which you are likely to want as you progress to more advanced work, and it applies particularly to slender wire rings or frames. Thick ones can be set with the pliers, which are then used to straighten or to bend the wire according as it is curved too much or too little in different places. But when annealing a slender ring or frame on a disc or otherwise shaped piece of sheet metal, you must remember that the sheet metal will expand as it gets hot, and that this and the surrounding wire must be heated evenly, or else the expansion of the former may burst the ring.

If you are making a ring of beaded wire like those shown in Figs. 5, 6, 9, take care that the wire is properly annealed before you bend it. As sold, it is generally quite hard, and when bent in this state the nicks between the beads make it very liable to break.

Unless the wire of which a comparatively large ring is formed is very thin indeed, its ends can be made to press close against one another while they are being soldered, just as was done with the small ones, except that it may first be necessary to close up the ring a little until the ends pass each other, and then spring it open until the two ends are pressed firmly together. But if the wire is so thin that this is difficult, it may be secured to the charcoal block with a few ordinary pins, so that the ends are kept properly in position. The pins should not be too near the joint, or they will be liable to get melted, and the solder may stick them to the wire.

All jewellery which is built up out of a number of separate pieces soldered together needs "boiling out" from time to time in hot pickle, so as to remove the borax and to restore a perfectly clean surface to the silver. When a joint is soldered, the borax melts into a kind of yellowish glass, which is so hard that, if you try to remove it with a file, this will be spoilt, but it is dissolved very quickly by hot pickle. Boiling out does not improve the silver, so that it should not be done oftener than is necessary, nor should the process be continued after the borax has been removed. Generally, a minute is long enough ; but as soon as the pickle has done its

work the silver will have assumed a dead pearly white colour all over, and then it should be well rinsed in clean water so as to remove all traces of the acid. If a second joint has to be made very near to a previous one, boiling out is advisable before the second soldering, because, if a nick is already full of vitrified borax, it is obvious that there will be no room there for solder as well.

It is quite possible that, by the time you have worked your way up to this point, you may feel that you would like to finish off completely one of the small ornaments which you have built up out of circular forms. If that should be so, then try making something easy, such as a button, or a shoe ornament, or a clasp.

But do not allow a perfectly natural and proper desire like that to interrupt for more than a few hours this journey, at the end of one stage of which you have now arrived.

If it should so be that you have found the first stage of the journey interesting, then rest assured that you will be sustained by a still keener interest in pursuing the second and later stages.

CHAPTER XVII

ABOUT DRAWPLATES

Figs. 5, 6, and 9 (pp. 13, 14, 19) gave suggestions of the variety and beauty of designs which are within the reach of a jeweller, even if he restricts himself to the use of circular forms only—that is to say, to the use of such forms as (i.) grains,  which, in jewellery, however, would always be smaller than this illustration indicates, and usually very much smaller than that; or (ii.) discs,  which, as we have already seen in Chapter III., are generally just grains that have been flattened by means of a little hammering; or else he may use (iii.) domes,  which enable him to obtain the full, bossy effect of grains on a much larger scale than is possible with grains, if that is desired, without the disadvantage of the corresponding weight which would be inevitable if they were solid instead of hollow; or (iv.) cups,  which may occasionally help a design of the kind we are now considering by supplying an agreeable contrast to all the other circular forms that we have at our disposal; or, finally, he may use (v.) rings,  which, indeed, form a very conspicuous feature in Figs. 5, 6, and 9. But, fortunately, there is no need to impose any such limitation as that, though it is true that it might well stimulate the invention, and that it would ensure a sense of unity in the resulting designs.

Now, however, let us consider what other shapes can be made out of short bits of wire, and, because it is easier for bending, and because, too, the objects which are made will

thus have a pleasanter and more interesting appearance, let us use flat wire instead of round. So long as we have suitable drawplates, it is just as easy to make wire whose section is oblong, or square, or triangular, or half-round, or oval, as it is to make it round.

There is no special advantage in always drawing your own wire, but when you want some of a size you have not got it is often very satisfactory to be able to draw it at once yourself instead of having to put up with the interruption and delay of getting it from a dealer, who also may not have any of that particular size or section in stock, and may perhaps keep you waiting for it. In any case, you ought, at least, to draw enough wire to realise how much it is possible to do by hand, and just how to do it.

Silver is a great deal too expensive for any ordinary craftsman who works on a small scale to be able to keep a stock of it in sheet and wire of all the many different sizes which he is ever likely to require for use.

From time to time stout wire will be wanted in small quantities, perhaps round, perhaps flat ; at other times, half-round or, it may be, square or triangular, so that, if the stock of spare silver has to be a modest one, it is best to have a length of round wire of, say, No. 12 I.S.G. for such purposes, and to cut pieces off this for drawing down when required. The round wire can soon be hammered either flat or approximately square on the steel stake, or, if it is to be half-round or triangular, you can hammer it into a groove of the right shape which has been filed across a suitable solid piece of iron or brass, and then, if you have the necessary drawplates, you can soon reduce a piece of the stout wire which you have now roughly forged into shape to the particular size and section which you happen to want. However, if you know beforehand definitely just what jobs you are going to do, it will be decidedly more economical to buy the silver in the form and size in which you are going to use it, if your own time is of more than very slight pecuniary value. Wire which is really stout cannot be drawn by hand, and in a fully-equipped workshop there will be a drawbench for

reducing it by mechanical means, and, similarly, a flatting mill for reducing the thickness of sheet. But these technical chapters are intended more particularly for the help of beginners who have very few tools, and none that cost more than a few shillings.

Drawplates are among the most expensive of these, but it will be assumed that you have three or four of them, two or three for round wire and one for flat wire. The largest of those for round wire (Fig. 15, G, p. 38) will probably have two rows of holes, and will draw wire from about No. 12 I.S.G. (No. 41 on the drawplate) to about No. 19 I.S.G. (No. 60 on the drawplate).

The second plate (Fig. 15, K), which follows the one last mentioned, has three rows of holes, and draws the wire from No. 19 I.S.G. to No. 27 I.S.G. (No. 90 on the drawplate). The third plate (Fig. 15, H) has two rows of holes for flat wire from 12 × 17 I.S.G. to 19 × 24 I.S.G.

Wire which will just pass through the largest hole in the first plate, *i.e.*, No. 12 I.S.G., is about as thick as can be drawn by hand, and then only if it has been properly annealed first.

Drawplates are commonly described by the shape of their holes, as, for example, round, flat (or oblong), square, half-round, or triangular, as the case may be, but the plates themselves are generally rectangular and oblong.

If you cannot afford to buy the three plates above mentioned do not worry too much about that. They are not absolutely essential even to the practice of the exercises in making simple ornaments out of wire which are explained in this book, because any good dealer will supply you with the wire ready for use in whatever sizes you need it.

For the benefit of any readers who can manage a tolerably simple bit of carpentry for themselves, and who feel that they would like to have a drawbench of their own, it seems to be worth while giving a description of this contrivance.

It is really a rather primitive kind of apparatus, and there is nothing very difficult about it so far as the woodwork is concerned. The tongs for gripping hold of the end of the

wire, by means of which the rest of the length is pulled through the drawplate, are made with hooked ends, as shown in Fig. 30, so that, when the big ring is passed over these turned-up ends of the handles, and when the ring is pulled by means of a strap or chain which is wound round a windlass

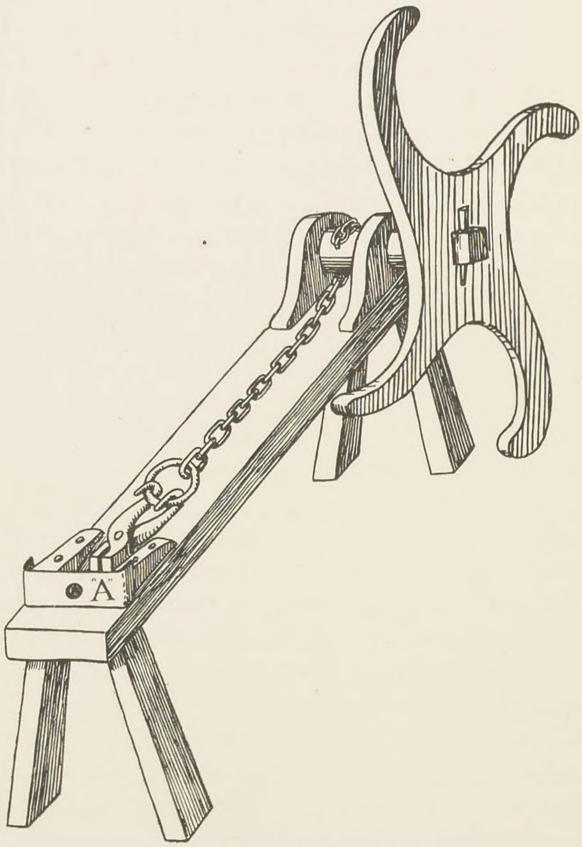


Fig. 30.—A drawbench.

at the other end of the bench, the tongs are automatically closed tightly on to the wire.

These tongs can sometimes be bought secondhand, or possibly a blacksmith would make a pair for you ; or if you have a powerful hand vice to the handle of which you can fix a strong hook or ring by which it can be connected to the

strap or chain, that would probably do well enough for all wire of moderate size.

The sketch (Fig. 30) will indicate clearly enough how the bench is constructed and how the drawplate is supported by resting on its edge near the end of the bench, against the iron plate " A."

The whole apparatus is an interesting thing to make, and a remarkably useful tool to have so long as there is comfortable space for it in your workshop.

For the following exercises you will want a considerable quantity of flat wire of, say, 19 × 24 I.S.G. size, and, for the sake of economy, such exercises may very properly be carried out in brass, copper, gilding metal, or German silver. Copper is very nice to use, owing to its softness ; but when a piece of work is built up out of separate parts and silver-soldered together, the heat of the soldering leaves the copper in its softest state.

This is very undesirable, for, if the ornament is accidentally dropped on the floor or if it is handled at all roughly, it will get bent out of shape directly.

Before the parts were soldered together, the copper will usually have been considerably hardened in the course of working, by bending and so forth. Gilding metal, which looks almost exactly like copper, and German silver, which looks like silver, are both so composed as to remain fairly hard even after exposure to the heat of the blowpipe flame, and they are, therefore, preferable whenever stiffness or durability is desired.

This consideration is of no importance when copper wire is only used for trying first experiments with units, etc., but if it is used for learning the art of silver soldering, it will be well to bear in mind that copper, being a particularly good conductor of heat, not only absorbs heat quickly, but also *loses* its heat quickly. The consequence is that, if you are uniting a number of copper wire units with silver solder, you must take especial care to get the whole group of units pretty hot all over before increasing the heat just where the solder is, because otherwise, as fast as you heat up the parts where

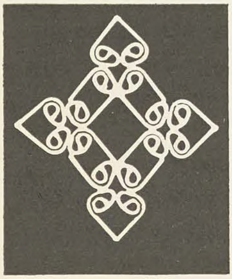
the solder is, the other parts will keep drawing the heat away by conductivity, and the solder won't melt. The same thing happens with silver, too, but not to anything like the same extent. German silver is rather less easy to solder, and it is not nearly so ductile as either silver or copper ; in fact, it is so hard that it causes much wear to drawplates.

You will need to use silver in the more advanced exercises, for many of the objects may be used later on as the bases of complete pieces of jewellery. But the results of the earlier exercises should be kept for future reference, on the sampler principle, so that it would be unnecessarily extravagant to use silver for these.

Roughly speaking, if a certain length of copper wire costs one *penny*, the same length of silver wire would cost from four to six *shillings*. Gilding metal and German silver are only slightly more expensive than copper. The difference in price is not enough to be of much importance in these small articles.

CHAPTER XVIII

DRAWING FLAT WIRE



WHATEVER metal you are going to use, the wire will be produced and worked in the same sort of way, and one of the most natural methods is to take a few feet of stout flat wire, measuring in width and thickness about 12 × 17 I.S.G., and to draw it down to the required size. This method is generally necessary if you are wanting one of the larger sizes of flat wire, say, any of the sizes given by the first three or four holes in your flat-wire drawplate (Fig. 15, H), and it is the obvious method to adopt unless you happen to be able to buy wire ready drawn to the size and section which you need. If you have no stout flat wire, and if you are unable to buy any that is suitable, you can soon flatten some round wire by hammering it on the steel stake. No. 13 I.S.G. round wire, when hammered flat, should go through the first hole in the plate for flat wire ; but try a *short* piece first, in order to make sure that it is right, and if it is still too large, draw the rest of the wire down another hole or two *before* flattening it.

You will naturally avoid drawing down the wire unnecessarily small while it is still round, because otherwise there will be a greater length of it to hammer flat. If you begin with flat wire which just fills the biggest hole, it will have been stretched to about six times its original length after it has been pulled through all the holes, including the smallest one.

Another plan often adopted when flat silver wire is wanted is to cut a narrow strip off a piece of thick sheet, but that

can only be done with the help of very big shears, and even then it is far from easy ; if you are so lucky as to have access to " guillotine " shears, it is not so very difficult, but for that job they must be powerful ones ; and, moreover, a beginner, if he had any sheet of the necessary thickness, would probably only have quite a small piece, which would not provide a long enough strip to be worth the trouble of drawing down. In that connection it should always be remembered, when wire is to be drawn, that the labour involved in drawing 6 inches of wire is very little less than that which will suffice to draw, say, 3 feet, unless it is thick stuff that you are dealing with.

Yet another alternative, that of casting a slender ingot, is also beyond the scope of the beginner.

It is quite possible to draw flat wire from a piece of ordinary round wire which has not been flattened at all, but care has to be taken in the early stages to avoid twists, for, after a piece of round wire has been pulled through *one* flat hole, it is flattened so slightly that it is quite likely to *turn* when pulled through the next hole ; and if this happens, it will probably break later on. Even if it does not break, the wire will probably be useless wherever such twists occur.

The easiest way to prevent twists and kinks, and to keep the wire from getting entangled, is to make it pass between two pieces of wood, between which it is fairly tightly pinched, at a distance of a few inches from the back of the drawplate.

When you are drawing anything more than quite a short length of wire, it is a great help to have a series of ordinary iron screw eyes fixed at intervals of 1 or 2 feet apart in a long length of slate lath or some other strip of wood, so that they may act as guides for the wire to pass through on its way to the drawplate. If you can fix these or something that will answer the same purpose direct on the wall of your workshop, probably that will be better still.

But when you come to draw a length of, perhaps, 20 or 30 feet of small wire, if you don't have some apparatus of this kind, you will certainly have trouble, unless, of course, you can get an assistant to hold the end of the wire for you

and to walk to and fro with it. Otherwise, before you pull the wire through a fresh hole, clip the beechwood ring clams on to the tail of the wire, to act as a slight drag and to keep the loose end from tying itself up into knots before it reaches the first screw eye. When the beechwood clams are stopped from travelling further by the first screw eye, the wire should slip out from the clams of itself, after which it will be free to pass along through all the screw eyes on its way to the drawplate.

Assuming that the wire has now been drawn down to the right size and carefully annealed (see pp. 42, 43), the next thing is to cut most of it up into short pieces, all of exactly the same length.

There is a useful little engineer's tool, called a slide gauge (Fig. 29, A, p. 78), which combines the functions of a short measuring rule with those of inside and outside callipers, and if you happen to have one of these or, what is handier still, a small steel square having an adjustable blade, which will slide in its stock so that it can be set with whatever length of projecting end may be desired, then you will have no trouble. But if it is a slide gauge that you have, then it must *not* be that kind which also serves as a "depth gauge," because in that kind the part which measures depths would get badly in your way. There are three kinds of steel squares, all of which have adjustable blades, and any one of them would do well for this little job: a 4-inch "combination" square (Fig. 31), or a double square of the same length, or a $2\frac{1}{2}$-inch "toolmaker's" square. The lengths given are the shortest which are usually sold, and a smallish tool is handiest for the job under consideration; but for most people a 4-inch square is small enough.

The combination square would probably be the most generally useful. The "toolmaker's" square is unnecessarily expensive for our purpose, owing to its extreme accuracy, but it is a pretty and neat little tool. The essential thing for the present purpose is an *adjustable* blade.

Whichever of these tools you have, all you need do is to set the sliding arm so that it leaves the end of the rule

projecting by exactly the length to which the wires are to be cut ; and then you hold the flat wire on this projecting end of the rule with your left thumb, so that the end of the wire presses against the sliding arm where it crosses the rule, and then you cut the wire with the side nippers (Fig. 31), working them against the end of the rule.

A very simple makeshift appliance can easily be devised to serve the same purpose. Take two flat strips of fairly stout sheet metal, equal in width, and see that their ends are square and smooth. Then bind them together with fine wire so that one piece projects beyond the other by the exact amount that the pieces of wire which you are going to cut ought to measure, and use it as described above. The exact size of the strips of metal for this appliance is unimportant, but what is commonly known as brass tape, $\frac{3}{8}$ inch wide by $\frac{1}{16}$ inch thick, is a convenient size to hold, and one piece might be 5 inches long, and the other, say, an inch less. The only really important thing is that the ends should be filed carefully, so as to be truly at right-angles with the length. Otherwise the projecting end will vary in length at different parts of its width. If you have an ordinary small steel square like Fig. 29, B, p. 78, the thin blade of that will provide one of these slips.

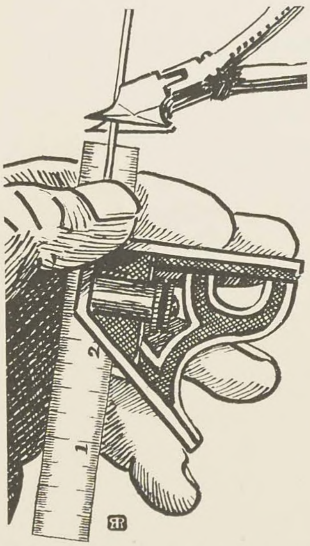


FIG. 31.—Using a 4-inch combination square for cutting off wire to a length with side-cutting nippers.

Two 4-inch × $\frac{3}{4}$-inch steel rules serve excellently for this purpose, and as they are very accurately made, you know that their ends are perfectly square with their sides, so that all you have to do is to secure them together in such a way that one rule projects beyond the other one by the required amount.

It is not very difficult to bend the two sides of a rectangular

piece of fairly stout sheet metal around the edges of the two steel rules, laid together, so as to make a sliding clip which will hold them together. The metal for such a clip should be No. 12 or 14 in the metal gauge. The rules can be bought with many different scales marked along their edges. A convenient pattern has thirty-seconds of an inch along one edge and fiftieths along the other.

A long length of wire will be easier cut up into short pieces if it is first divided into moderate lengths of, say, 3 or 4 feet each, and if these are firmly stretched with two pairs of pliers until they are perfectly straight and free from any tendency to curl up. They can then be laid flat across the bench or table, under a book or other moderate weight, to prevent the wire from shooting away each time a bit is cut off, as it would otherwise do. In order to straighten wire by stretching, it must first be properly annealed.

Fig. 32.—Method of securing a number of short lengths of wire in order to make the ends square.

Seven-eighths of an inch is a convenient length for the bits of wire, and when these have been cut off, they ought all to have their ends ground or filed flat and square, so that all the wires may be exactly equal in length. For first experimental trials, however, this is hardly necessary ; but the method which is recommended for performing this operation is described here because this seems to be the right place for it.

Fig. 32 shows a number of pieces of flat wire, all cut to the same length, and held together in a short bit of tube for the process of squaring the ends. It is important that the ends of the tube should be perfectly square with its sides.

If you have a lathe, or if you can get a friend to turn the ends of the tube true for you, that is quite simple. Otherwise, the easiest way is to cut out an oblong piece of thin sheet metal of a suitable size, say, about $1\frac{1}{8}$ inch × $\frac{5}{8}$ inch × 27 I.S.G., file the ends quite square with the sides, bend it round into a tube, paint the joint with borax water, bind the tube round with soft iron binding wire as in Fig. 33,

"charge" the joint and silver-solder it. Set the tube upright on the steel stake, fill it *quite full* with pieces of wire, and satisfy yourself that they are standing quite vertical upon the stake. Then warm the wires with the blowpipe flame moderately, so that when a very little jewellers' cement is melted on to the top ends of the wires it sinks in between them and seals them all together. Let the cement get cold, and then slide the tube along the wires away from their unsealed ends, set them up so that they stand upon their *sealed* ends, and melt a little cement on to the other ends, which are now uppermost, so as to seal these, just as you did with the others before.

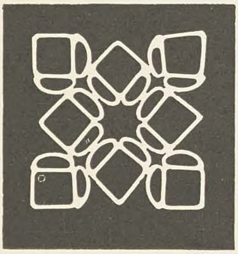
FIG. 33.—Method of using iron binding wire.

When the cement is cold, rub the ends of the wires until they become smooth, on a piece of medium emery cloth (say, F.F.) which is stretched over the steel stake. It would involve too much work to rub the ends of the wires down until they all looked quite square and even, and something a little short of that will do.

When you can see that you have smoothed down the sharp points on *all* of them, then treat the other ends in the same way; and finally, lay the bundle of wires on the soldering wig or on the charcoal block and play upon them rather gently with the blowpipe, until all the jewellers' cement has been burnt away. Afterwards you will find it quite easy to separate all the wires one from another.

CHAPTER XIX

A FIRST EXERCISE IN DISCOVERING UNITS, AND IN CONSTRUCTING PATTERNS WITH THEM



It is quite possible that some readers may not agree that $\frac{7}{8}$ inch is a convenient length to adopt out of which to make their units. But the question of whether or not this is the best length for any particular craftsman will depend (1) on the pliers which he has, and (2) on any individual peculiarities or limitations which there may be (*a*) in his way of handling the pliers or (*b*) in his preference for this or that formation of unit. Possibly it may also depend on whether or not he happens to be a student of, and a believer in, dynamic symmetry.

Personally, I regret that my own acquaintance with Prof. Jay Hambige's fascinating theory is so slight and recent that I am unable to speak authoritatively as to its applicability to such a question as the length of wire appropriate for making units, but a few experiments seemed to prove that its application would of necessity demand that all the pliers used for making the units should also conform to the standard of proportion which might be selected.

Before deciding whether he will select a special length of his own or whether he will just adopt $\frac{7}{8}$ inch, the reader's wisest course will be to make some trials with the $\frac{7}{8}$-inch length, in order to determine whether it does or does not actually conform to the conditions mentioned above. It is necessary for him to begin by acquiring some familiarity with the various bending processes, which, although not very difficult to perform, do, nevertheless, require practice

if they are to be done properly. It is also necessary to realise how the system of designing by the arrangement of units works, and how much may depend on very slight differences in the shape of the units.

Now take one of your $\frac{7}{8}$-inch lengths of wire and your small round-nosed pliers (Fig. 19, N, p. 45), and make a trial unit. But before actually doing this, read on as far as the words " and set to work," on p. 96, first, and then put the book aside and resolve not to look at the illustrations until you have finished the following exercise. For this one it will be best to keep to the instructions which are given here :—

Bend the two ends of the wire in any simple, easy, regular way which seems natural to you, or which may be suggested to your mind by watching the action of the pliers upon the wire. But be careful to observe just *how* you do it, and let any shape which you decide to make be of such a kind that it will be easy to bend a number of other wires exactly like it. Leave the middle part quite straight. Then make about three dozen units as nearly the same as you can.

Take three of these and arrange them so as to form a plain triangular cluster. Solder them together in that arrangement, and afterwards make as many identical triangular clusters as your supply of units will admit of. Place these clusters together, first in groups of two, then three, then of four, and so on, arranging them sometimes with their *sides*, and at other times with their *points*, together ; and if any of these groups look likely to be useful—that is to say, if you think that they provide the skeleton or basis of a satisfactory design—then make a note or record of this arrangement at once, according to the method which will be described in a moment ; and having done so, just go on trying every other different way you can think of in which the clusters can be associated together. While doing this, always keep a keen look-out for any suggestions of still other groupings which you have *not* thought of, such as will probably be indicated from time to time by the relative positions into which perhaps two or three of the clusters may have

come together accidentally, and continue all the time to make notes of those groupings which are effective.

Next try developing some of these arrangements into more elaborate designs by adding on additional clusters around the outside of each group ; and finally, try if you can improve their appearance by decorating either their surfaces or their contours with grains, either singly or in clusters, and similarly with discs, rings, or domes.

For making notes or records of groupings, as also for trying the effect of decorations by means of grains, etc., it will be found a good plan to have a supply of soft modelling wax, and to spread thin layers of this as smoothly as possible on, say, pieces of ordinary tinned sheet, such as the lids of cigarette boxes or biscuit tins. Stiff cardboard will do, but that is not so good, because the oily moisture of the modelling wax gets gradually absorbed by it. Real modelling *wax* should be used rather than the cheaper substitutes, most of which very quickly stain and corrode any metal that is kept in contact with them. An ounce of the best jewellers' soft red modelling wax can be spread out to cover about 16 square inches ; but it *must* be soft, in order that it may be easily spread, and so that it may retain the units in place when they are pressed down into it.

If you have access to an ordinary office copying press, that will enable you to spread the wax smoother and quicker than can be done by hand, but even then the preliminary spreading should be done with the fingers. After this, it should be covered with a sheet of tracing paper which has been very slightly greased with vaseline, so that when the wax has been pressed flat the tracing paper may come away without bringing any of the wax with it.

Often it may not be convenient to leave the units embedded in the modelling wax, merely in order to preserve a memorandum of a certain grouping for future use ; nor is this necessary.

When the units or clusters have been firmly pressed down into the wax, it should be possible to remove them fairly easily, one at a time, with the help of a pair of tweezers, and

yet to leave a sufficiently clear impression of the whole design in the wax, so that it can be reconstructed at any future time without having to rely very much on the memory. If the wax sticks to the units, dip the latter in French chalk before pressing them down into the wax, but do not let them have more than a very slight dusting of chalk on their surfaces.

These wax records will remain perfectly clear for years, so long as they do not get crushed or overheated.

Tiny fragments of wax will also greatly facilitate experiments in decorating unit designs with grains, discs, etc., as these small parts can then be kept in the exact positions desired until the whole effect can be judged.

Experimental arrangements of clusters, grouped together in the way which has been recommended, will help you to realise, if you do not already know it, that there are unexpected possibilities of design to be found in the mere repetition and orderly arrangement of very simple forms. It is a mistake to begin with elaborately formed units, and you may perhaps find yourself building up quite passable patterns out of what may have appeared to be unpromising material.

Also, this exercise should make the next few chapters more interesting than they would otherwise have been.

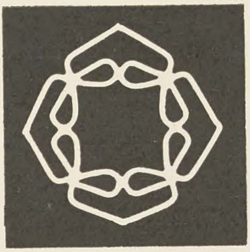
And now it may be as well to read through this much of the present chapter once again, and then to put the book aside and set to work.

When you have completed the exercise which has just been described, you will have obtained a first insight into what is perhaps the most interesting aspect of "unit jewellery," because you will have found out by personal experiment that designs *do come* of *their own accord* if the very simple method which has been described is followed intelligently. Perhaps the design which has resulted from your first experiment in the "unit jewellery" method may strike you as uninteresting and disappointing.

Well, don't let that discourage you. Although it *is* a semi-automatic method of designing, there is a lot to learn about right and wrong ways of pursuing the method, and

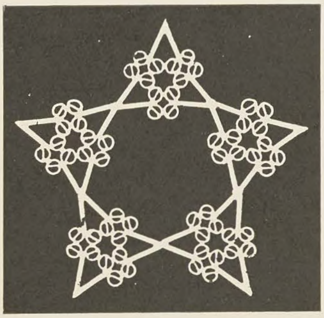
experience is needed to enable us to *perceive* a good thing, for most of us are quite capable of overlooking one sometimes when it actually lies upon the bench in front of our eyes.

An important truth, which may not seem obvious at first, is that, when you are designing by means of a number of repetitions of clusters, each one of which is composed of two or three or more repetitions of some one unit, then a portion of the wire which forms that unit should, as a rule, be kept straight.

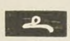


CHAPTER XX

STRAIGHT LINES AND CURVES



THE contrast between straight lines and curves is one of the most important sources of beauty which we have at our disposal, and when the same forms are repeated and reversed many times in close association a very subtle departure from straightness in one of the lines may be enough to produce an astonishing difference in effect.

Sometimes, too, the beauty of the resulting design may actually depend on the slightness of the curve which has been introduced, or on the smallness of the curved part in proportion to that which has been allowed to remain straight. To explain this graphically, let us take , which is a unit of the " V " type. Then let us make a number of these, and afterwards let us modify some of them very slightly by curling the extreme end of the long, straight part just a little, and so producing . The next step is to arrange these units in clusters, and in doing so let us keep those of the original form by themselves, thus  ; and in precisely the same way let us also make some similar, but different, pairs of the other ones whose shape has been modified .

A comparison of these two clusters shows that the consequences of a trifling modification are more noticeable when the units are placed together in pairs than when each unit is seen singly ; and if we now take more of these same two clusters and solder them together into larger arrangements

(Fig. 34), using, let us say, four pairs of units for each of the larger arrangements, it becomes obvious that a very slight modification of the straightness of one line has produced a rather remarkable variation in the final effect when all the units are assembled together. We see, also, that while an arrangement which is made up entirely of repetitions of the

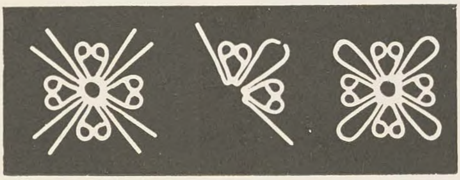


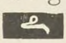
Fig. 34.

original unit may produce an effect which is merely curious and jagged and incomplete (Fig. 35), yet, on the other hand, an exactly similar arrangement made up of an equal number of repetitions of the very slightly modified unit gives us a neat and pretty little border (Fig. 35A), and that here, again, the appearance of the two patterns produced is surprisingly dissimilar, although the units which are employed are so very nearly identical.

The difference is certainly less noticeable when the units are so placed that all the loose ends of the wires are united

Fig. 35.

Fig. 35A.

to other loose ends in such a way as that which is exemplified in Figs. 36 and 37; but, still, the characteristic cusping which we get in Fig. 37, from the slightly curled ends of the wires  that come together in pairs at many of the angles, gives that design a certain vigorous compact and finished appearance which is absent from the more spidery Fig. 36.

The effects which result from assembling groups of units together rhythmically are, however, nearly always sure to be interesting, and they will frequently recall the shapes of flowers, buds, seed vessels, or other familiar objects in

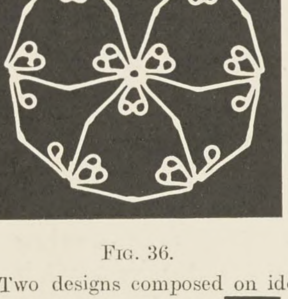


Fig. 36.

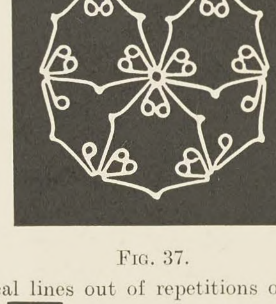
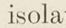
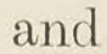
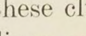
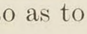


Fig. 37.

Two designs composed on identical lines out of repetitions of  and .

nature. Fig. 38 shows isolated and side by side the salient forms contained in Figs. 36 and 37.

If we now join together some more pairs of these same two units, but on a plan which is different from the one adopted on p. 98, so as to give us this time  and , and if we proceed to use repetitions of these clusters so as to make two simple patterns on identical lines, such as Figs. 39 and 40, we shall have another example of a considerable difference between one and the other which is due solely to the very slight variation in the forms of these two units.

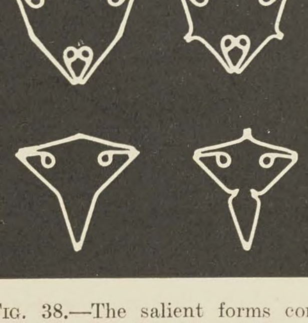


Fig. 38.—The salient forms contained in Figs. 36 and 37.

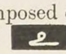
We naturally get from these clusters arrangements like Figs. 39 and 40, the result of the curl at the end of the straight line being in this case to give us five rather

pretty long-pointed spaces in Fig. 40, which do not occur at all in Fig. 39.

In all these examples of the use of  and  the effects obtained must necessarily depend appreciably on making the corresponding angles identical in each repetition of any particular cluster. There is no very great difficulty in doing this, but the angles won't come alike of themselves, and it is one of the many instances where carelessness in an early stage of the work is sure to cause disappointment and repentance later on. Consequently, whenever the angle made in the construction of a unit or of a cluster is an essential factor in the design which is contemplated, it is desirable to make a simple gauge by which

Fig. 39.

Fig. 40.

Two other designs composed on identical lines from repetitions of  and 

to test and correct these angles. It is merely a case of filing or cutting out a notch in the edge of a bit of sheet metal; or if you are so fortunate as to possess a universal bevel gauge or a "multigauge," either of these tools can be set in a moment to register any desired angle.

However, when it is just a case of equilateral triangles, there is no need to bother about any superlative degree of accuracy. Your eye should tell you when the three angles are nearly enough alike. Examples of designs built up out of equilateral triangular clusters occur on pp. xxxiii. and 23, and with such an arrangement, formed from a unit like , which, from our present point of view, we may regard as being to all intents and purposes merely a straight line, you cannot go very far wrong. But, naturally, with such a unit no great variety of designs is possible. These triangular

patterns, however, serve as further illustrations of the value in design of introducing little bits of curved lines to soften and contrast with the straight lines which predominate, and, by means of repetition, they help in the formation of more interesting shapes.

The remarks on pp. 94, 97, 166 as to the need of keeping some part of each unit perfectly straight must be treated with a reasonable degree of latitude. Such words are not intended for *universal* application, but, like most other general recommendations, they may be disregarded quite safely in certain obvious instances. There may perhaps be a small portion of perfectly straight wire in , which is a unit out of repetitions of which some of the chapter heading ornaments were built up, as, for example, those which come on pp. 81 and 222; but this, like many others of the "S" type of units, is nearly all curves, and many equally curly units make good patterns even quite by themselves. This is true of  and , both of which occur frequently in some later illustrations, and in neither of them is there any suggestion even of a straight line. The same is true of a great many of the units which belong to the "crescent" type, as, in fact,  does.

NOTE.—In order that the "type size" diagrams of single units, and of groups of two or three units, might show up clearly, it was necessary to exaggerate in some cases the width of the white line, in others that of the spiral line of black background.

CHAPTER XXI

WHAT A PLAIN CRESCENT UNIT WILL DO

AS an example of a unit which, although it follows a simple curved line throughout, will, none the less for that, provide us with many good patterns without the help of any other unit, we cannot do better than take .

In these patterns (Fig. 41) and probably in any which result without effort from rhythmically repeated arrangements of simple curved lines, there need be no undue sense of monotony or restlessness from the lack of straight lines. Such defects are more likely to occur when the line of each unit is made up of several *different* curves unrelieved by straight lines, or when the curve is of a quick, full or bulgy shape, rather than of the slow, easy kind which was selected for use in the examples illustrated in Fig. 41.

It may be as well to mention that units of that description, although they look so simple, are not easy to make correctly without a *swage* or shaping block of some kind, by pressing them into which we may be sure that they will all be as nearly as need be identical in curvature.

Most people will know what a blacksmith's swage block looks like, even if they do not happen to be familiar with the name. It is a large, heavy block of iron perforated with holes of different sizes and shapes, and its sides or edges are provided with a number of variously-formed grooves, some of which will generally impart a circular curve to a piece of metal which is hammered or pressed into them (p. xxxii.).

Similar swage blocks of a very much smaller size, and

provided with curved grooves only, are sold for silversmiths and jewellers, but even these are not very cheap.

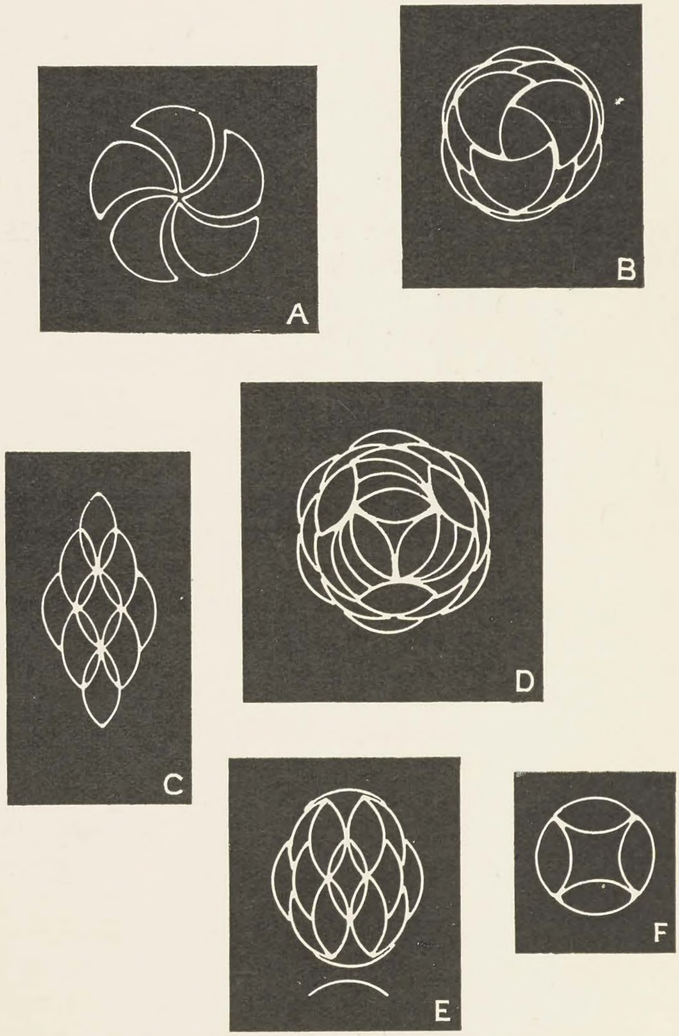


FIG. 41.—Designs evolved from repetitions of only.

However, for making crescent-shaped units, a resourceful craftsman will not be long in finding some suitable makeshift appliance.

For these and suchlike jobs it is most desirable to accumulate a box or drawer full of any odds and ends (not necessarily of metal only) which look as if they might at some time serve a useful purpose.

Short ends of tube, such as gas or water pipe, iron sockets, flanges, T-pieces, elbows, etc., broken pieces of iron gutter, shafting collars, pieces of broken pulleys, door knobs, poker handles—any such things as these which have either a smooth, even groove or else a nice rounded surface—may easily enable you to perform some otherwise difficult job well and accurately, and with the minimum of expense and trouble.

For making  or other units of a similar character, if your box of odds and ends will not meet the case, you can easily make a sheet-metal bending block. To do this, strike part of a circle with compasses or dividers, so as to mark the *hollow* curve you require, near the edge of a piece of thick sheet brass. Cut or file away the metal until the line you have marked is only just visible. Fix this plate down on to another smooth piece of sheet metal (or a piece of smooth, fairly hard wood will do), as a background on which to lay your straight pieces of wire across the hollow curve, into which you will now be able to press them. This pressing can be done either with another piece of sheet metal shaped to the right curve at one end or with any other suitable object which happens to have the right degree of curvature, such as a round tin box or even, perhaps, a penny. So much for imparting the same degree of curvature to each unit. But it must be admitted that even then they are not very easy to use afterwards when it comes to soldering them together, except when they are united first in pairs  or in triplets , both of which forms are fairly easily made. However, if you wish to use this type of unit singly, the difficulty consists mainly in knowing how to set to work.

To begin with, if you are going to make either C or E in Fig. 41, then you should first place two units together  so that their ends all rest upon or against a straight line. Solder them at the point of contact, and then

solder another pair together in exactly the same way. Then place these two pairs back to back , and when you are sure that the ends of the units are all quite level one with another, so that the four of them combine to make a perfectly symmetrical and regular figure, again solder at the points where the backs of the units are in contact.

Now you can proceed to add the other units, one or two at a time, without much fear of producing a lopsided ornament.

But C and E (in Fig. 41) are both rather difficult to construct truly and symmetrically.

It will be noticed that the points of the middle pair are separated by two wires in both C and E, and that in C a similar thing happens, but at one end only of the top and bottom pairs.

Consequently, the outer ends of these top and bottom pairs do not *naturally* come together in a point, but have to be coaxed. These little details help to give the patterns an increased interest to the eye, partly because the central spaces are thus endowed with a certain degree of superiority as compared with the other spaces, but they do involve some difficulties which beginners will do better to avoid.

Fig. 42, which may perhaps look more troublesome and complicated than those others just mentioned, is really rather easier to construct than either C or E in Fig. 41. It is based on a circular central group, which is made of four pairs of units after these pairs have been soldered together at their points . That is fairly easily done, and the remaining units are added gradually around this central nucleus without any special difficulty.

It is worth while to note how much of the charm of this design is due to the four tiny peaks which come at regular intervals around the central group, and show what very slight additions may suffice to cause a *circle* to suggest the idea of a *square*. The larger peaks, coming between the small ones, combine with the adjoining curves to produce a form that is somewhat reminiscent of the so-called "fishes' purses" which so delight children when they find one washed up on the shore.

We see from this design that it is quite possible to suggest to the mind of the observer the *idea* of straight lines simply by the way in which a number of units are associated together even when all the lines which enter into the composition are unmistakably curved. A suggested idea of this kind may often be more pleasing to the eye than a mere uncompromising statement of fact which leaves nothing for the imagination to play with. The pattern which forms

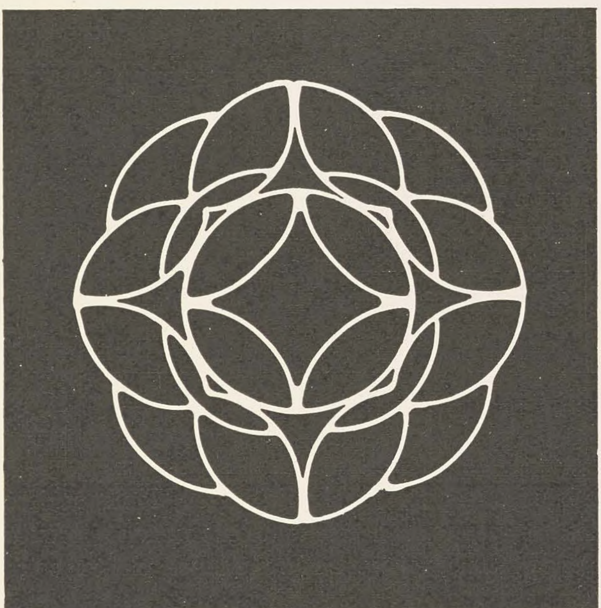


FIG. 42.—A design made from repetitions of  only.

the chapter heading on p. 125 is another example of the same kind of thing.

Conversely, a curve which is suggested by a series of *straight* lines may easily be quite interesting and subtle in character.

An example of this occurs on p. 98, but as this illustration is made from a "sun-print" of a very roughly constructed experimental pattern, the curves are not nearly as good as they would be if the thing had been more carefully built up.

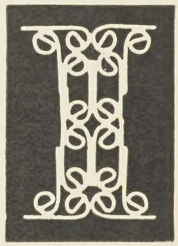
A casual glance might lead an inexperienced observer to suppose that none of the lines in this pattern were actually straight. It is, however, built up entirely of repetitions of , and the wires out of which these units are formed are bent only at the one end where the loop is formed.

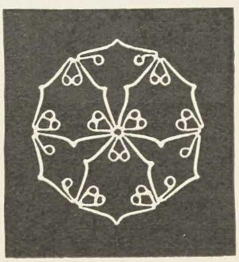
Here, again, is another pattern composed of the same materials and with a similar result, the central groups of units very definitely suggesting a circular line enclosing them, and the other lines which are formed by the straight parts of the units all appearing to follow other similar curves and undulations.

The ornament on p. 87 gives an example of an oval suggested by four straight lines.

Although purely a matter of design, and not in any way

connected with jewellery work, it may not be altogether out of place here to allude, in passing, to the way in which Fig. 42, as well as several of the other patterns evolved from the same unit, seem to offer suggestions for such different crafts as those of the glazier, the bookbinder, or the blacksmith; while the pattern which is used as a tailpiece on this page looks as if it might not need so very much elaboration to make it suitable, on an enlarged scale, for part of a modelled plaster ceiling.





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